RISK FACTORS AFFECTING THE OUTCOME OF MANAGEMENT OF TROCHANTERIC FRACTURES WITH SLIDING HIP SCREW IN ELDERLY : A RETROSPECTIVE AND PROSPECTIVE OBSERVATIONAL STUDY

Dissertation submitted to

THE TAMILNADUDR.M.G.R. MEDICAL UNIVERSITY,
CHENNAI,

In partial fulfilment of the requirements for the degree of

MASTER OF SURGERY IN ORTHOPAEDICS

Under the guidance of
Dr. B. K. DinakarRai., D.ORTHO., M.S. (ORTHO) ,

Professor & HOD
DEPARTMENT OF ORTHOPAEDICS,
PSG INSTITUTE OF MEDICAL SCIENCES AND RESEARCH
COIMBATORE

2016

Declaration

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **“RISK FACTORS AFFECTING THE OUTCOME OF MANAGEMENT OF TROCHANTERIC FRACTURES WITH SLIDING HIP SCREW IN ELDERLY : A RETROSPECTIVE AND PROSPECTIVE OBSERVATIONAL STUDY”** is a bonafide and genuine research work carried by me under the guidance of **Dr.B.K. DinakarRai, M.S Ortho,** Prof and HOD, Department of Orthopaedics, PSGIMS & R, Coimbatore.

Place:

Date: **Dr. Abhishek Mannem**

Certificate

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"RISK FACTORS AFFECTING THE OUTCOME OF MANAGEMENT OF TROCHANTERIC FRACTURES WITH SLIDING HIP SCREW IN ELDERLY : A RETROSPECTIVE AND PROSPECTIVE OBSERVATIONAL STUDY"**is a bonafide work done by Dr.AbhishekMannem in partial fulfilment of the requirement for the degree of M.S. (Orthopaedics)

Place

Date

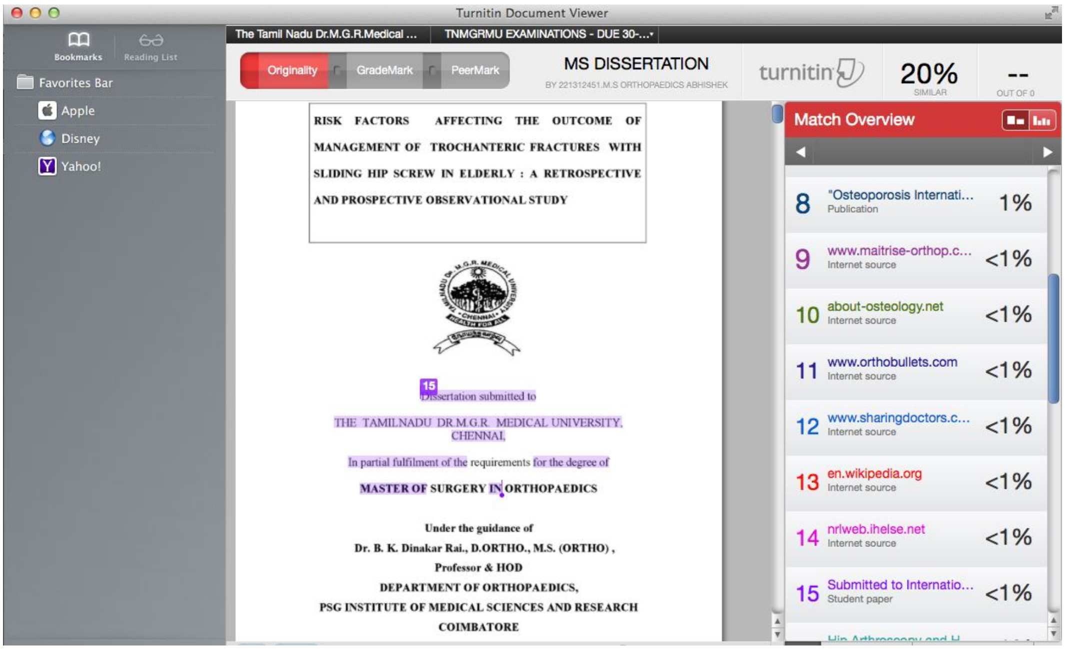
Dr. B.K. DINAKAR RAI
M.S.(Ortho)Professor & HOD,
PSG IMS&R,
Coimbatore.

ENDORSEMENT BY THE HOD / HEAD OF THE INSTITUTION

This is to certify that the dissertation entitled **"RISK FACTORS AFFECTING THE OUTCOME OF MANAGEMENT OF TROCHANTERIC FRACTURES WITH SLIDING HIP SCREW IN ELDERLY : A RETROSPECTIVE AND PROSPECTIVE OBSERVATIONAL STUDY"** is a bonafide research work done by **Dr. ABHISHEK MANNEM**under the guidance of **Dr.B.K.DINAKAR RAI, M.S (Ortho),** Professor & HOD, Department of Orthopaedics, PSGIMS&R, Coimbatore.

Dr. RAMALINGAM	**Dr. B.K.DINAKAR RAI**
Dean,	Prof. and HOD,
PSGIMS & R	Department of Orthopaedics
Coimbatore.	PSGIMS & R,Coimbatore.
Date	Date
Palce	Place

PLAGIARISM CERTIFICATE



PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)

POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA

Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

June 27, 2014

To
Dr Abhishek Mannem
Postgraduate
Department of Orthopaedics
PSG IMS & R
Coimbatore

The Institutional Human Ethics Committee, PSG IMS & R, Coimbatore -4, has reviewed your proposal on 20th June, 2014 in its expedited review meeting held at IHEC Secretariat, PSG IMS&R, between 10.00 am and 11.00 am, and discussed your study proposal entitled:

"Risk factors affecting the outcome of management of interrtrochanteric fractures in elderly: A retrospective and prospective observational study"

The following documents were received for review:

1. Duly filled application form
2. Proposal
3. Informed consent forms
4. Confidentiality statement
5. Application for waiver of consent
6. Permission letter from concerned Head of the Department
7. CV
8. Budget

After due consideration, the Committee has decided to approve the study.

The members who attended the meeting at which your study proposal was discussed are as follows:

Name	Qualification	Responsibility in IHEC	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
Dr P Sathyan	DO, DNB	Clinician, Chairperson	Male	No	Yes
Dr S Bhuvaneshwari	M.D	Clinical Pharmacologist Member - Secretary	Female	Yes	Yes
Dr Sudha Ramalingam	M.D	Epidemiologist Alt. Member - Secretary	Female	Yes	Yes
Dr Y S Sivan	Ph D	Member –Social Scientist	Male	Yes	Yes
Dr D Vijaya	Ph D	Member – Basic Scientist	Female	Yes	Yes

The approval is valid for one year.

Proposal No. 14/188

PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee
Recognized by The Strategic Initiative for Developing Capacity in Ethical Review (SIDCER)
POST BOX NO. 1674, PEELAMEDU, COIMBATORE 641 004, TAMIL NADU, INDIA
Phone : 91 422 - 2598822, 2570170, Fax : 91 422 - 2594400, Email : ihec@psgimsr.ac.in

We request you to intimate the date of initiation of the study to IHEC, PSG IMS&R and also, after completion of the project, please submit completion report to IHEC.

This Ethics Committee is organized and operates according to Good Clinical Practice and Schedule Y requirements.

Non-adherence to the Standard Operating Procedures (SOP) of the Institutional Human Ethics Committee (IHEC) and national and international ethical guidelines shall result in withdrawal of approval (suspension or termination of the study). SOP will be revised from time to time and revisions are applicable prospectively to ongoing studies approved prior to such revisions.

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Yours truly,

SECRETARY
PSG IMS&R
COIMBATORE-641004.
INSTITUTIONAL HUMAN ETHICS COMMITTEE

27.6.14

Dr S Bhuvaneshwari
Member - Secretary
Institutional Human Ethics Committee

Acknowledgement

Acknowledgement

At the outset. I thank the god for giving me the strength to perform all my duties.

It is indeed a great pleasure to recall the people who have helped me in the completion of dissertation .Naming all the people who have helped me in achieving this goal would be impossible, yet I attempt to thank a selected few who have helped me in diverse ways.

I acknowledge and express my humble gratitude and sincere thanks to my beloved teacher and guide **Dr. B.K.DinakarRai, M.S (Ortho),** Professor & HOD, Department of Orthopaedics, PSGIMS&R, Coimbatore for his valuable suggestion, guidance, great care and attention to details, that he has so willingly shown in the preparation of this dissertation.

I owe a great deal of respect and gratitude to my professor**,** **Dr.ShyamSundar M.S (Ortho)** for his whole hearted support for completion of this dissertation.

I owe a great deal of respect and gratitude to my professor**,** **Dr.ARVIND KUMAR M.S (Ortho)** for his whole hearted support in completion of this dissertation.

I also express my sincere thanks to my Associate professors **Dr.N.Venkateshkumar**D.orth. DNB, **Dr.Prasanna C** M.S (Ortho), **Dr.Vijayanth K** M.S, DNB Ortho, FNB(Spine), **Dr.Raghuveer**

Chander MS.Ortho; DNB, Department of orthopaedics, PSGIMS&R, Coimbatore for their timely suggestions and all round encouragement. I am immensely indebted to my grandparents and parents for their continuous support without them this study couldn’t have been reality.

My sincere thanks to the OP staff, post graduate colleagues and my friends for their whole hearted support.

Finally I thank my patients who formed the backbone of this study without whom this study would have not been possible.

Contents

TABLE OF CONTENTS

Introduction

Aims and Objectives

Review of Literature

Materials and Methods

Results

Discussion

Conclusion

Case images

Bibliography

X – Ray Images

Master sheet

INTRODUCTION

Intertrochanteric fractures are seen with increasing number and severity as the life expectancy of our population is increasing. The primary goal in the treatment of these Intertrochanteric fracture is to return the patient to his / her pre - fracture activity as early as possible. Early mobilization of these patients reduces the morbidity and mortality rate.

Before the introduction of fixation devices, treatment of intertrochanteric fractures was mainly non-operative, consisting of prolonged bed rest in traction until fracture healing occurred (Nearly 2 months), followed by a lengthy programme of ambulation training. In elderly patients, this approach was associated with high complication rates including Decubitus ulcers, Joint contractures, Pneumonia and Thromboembolic complications,Urinary tract infection, resulting in a high mortality rate. In addition, fracture healing is generally accompanied by varus deformity and shortening because of inability of traction to effectively counter act the deforming muscular forces.

For all these reasons, the treatment of intertrochanteric fracture by closed or open reduction and internal fixation has become the gold standard method of treatment.

Intertrochanteric fractures with severe comminution and displacement are commonly seen in elderly patients. All these elderly patients have poor bone quality and fractures are often associated with complications like non union , implant failure and femoral head perforation.The primary aim of treatment is stable fixation and early weight bearing mobilization.Stable intertrochanteric fractures can be easily treated by osteosynthesis with predictable good results.Management of unstable intertrochanteric fractures is challenging because of osteoporosis , Excessive collapse, loss of fixation , implant failure , lag screw cut out resulting in unpredictable outcome.

Many treatment modalities have come up in management of these unstable intertrochanteric fractures, Each having their own share of complications. Sliding Hip Screw Fixation is still the Gold standard in treatment of any type of trochanteric fracture. Research has shown that several factors like fracture type, fracture reduction, position of head screw, Tip apex distance, lateral wall thickness , displacement have their effect on outcome.

In our present study we have analyzed the factors that affectthe outcome of intertrochanteric fractures treated by Sliding hip screw fixation.

AIMS AND OBJECTIVES

Aim of the study:

The aim of this study is to assess the risk factors and their affect on outcome of intertrochanteric fractures treated by sliding hip screw.

Objectives:

1. To correlate the local factors affecting the outcome of intertrochanteric fractures treated with SHS fixation.
2. To observe the affect of multiple local factors in combination on the outcome.
3. To observe the effect of systemic and local factors together on outcome of intertrochanteric fractures.

REVIEW OF LITERATURE

Intertrochanteric fractures account for nearly fifty percent of fractures around the hip. They continue to be a major cause for disability leading to reduced quality of life and also death. **S SBabulkar** in 2006 stated that 90% intertrochanteric fractures of femur in elderly occurs commonly through osteoporotic bone due to simple fall[1,2] , where as in young individuals it may be a result of high energy injuries such as motor vehicle accidents or fall from height.[2]

Stable fixation with early mobilization is the treatment goal in intertrochanteric fractures of femur. Restoration of mobility in intertrochanteric fractures ultimately depends on surgical construct. **Arunsingh et al** in 2006 have proposed that although many devices can achieve rigid fixation,the DHS is the most commonly used device for intertrochanteric fracture of femur.[3]Proximal femoral nail though biologically more stable has not yet proved superior to sliding hip screw.

ANATOMY

Upper end of femur consists of head, neck, greater trochanter, lesser trochanter, intertrochanteric line and intertrochanteric crest.

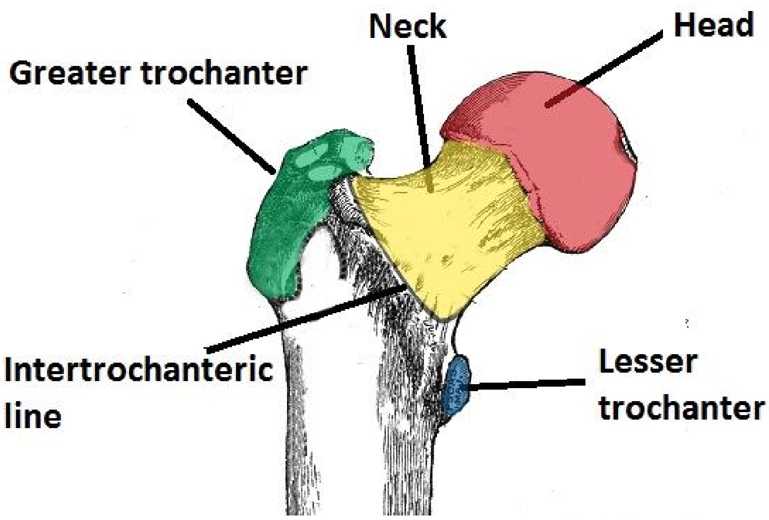
The femur is the second long bone in the body to start ossifying. The primary centre appears in the shaft during seventh week of intrauterine life. Four secondary centers, one for lower end appears at the end of ninth month of intrauterine life, one for head appears during first six months of life and fuses at around 16yrs , one for greater trochanter appears during fourth year and fuses at around 14yrs, and one for lesser trochanter appears during 12 yrs and fuses by around 13yrs.

HEAD OF THE FEMUR:

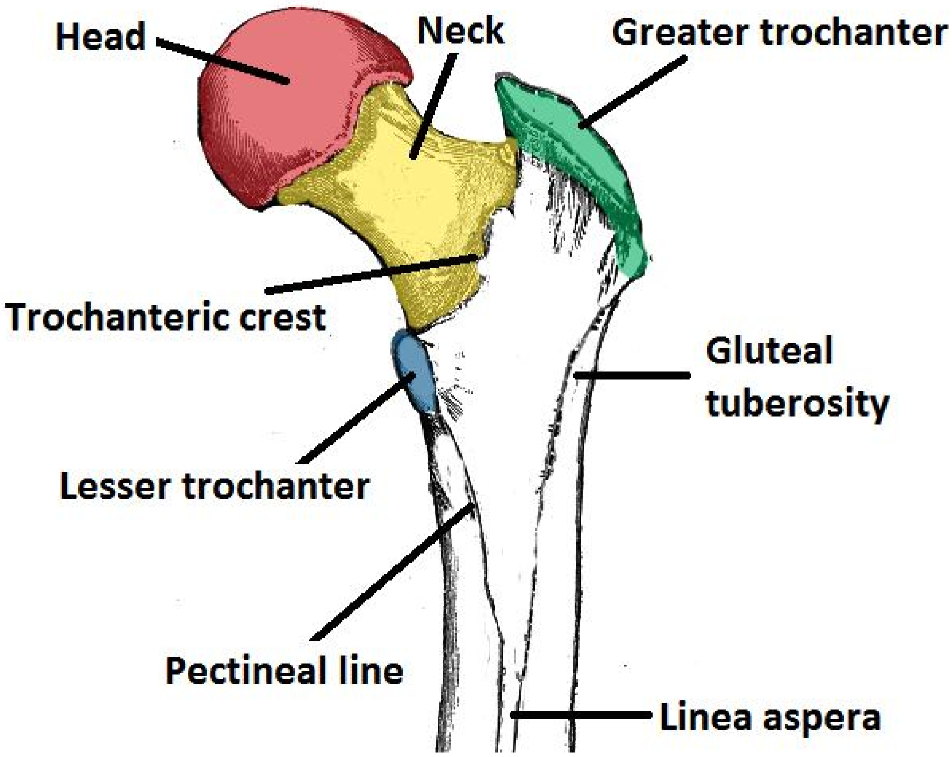
The head of the femur also called caput femoris is globular in shape and forms more than a hemisphere and is directed upwards,medially and slightly forward. The surface of the head is smooth,coated with cartilage and articulates with the acetabulam to form the hip joint. The head consists of a roughened pit, situated just below and behindits centrewhich is called the foveacapitisfemoris. It provides attachment to the ligament of head of femur (the round ligament or ligamentumteres).

NECK OF THE FEMUR:

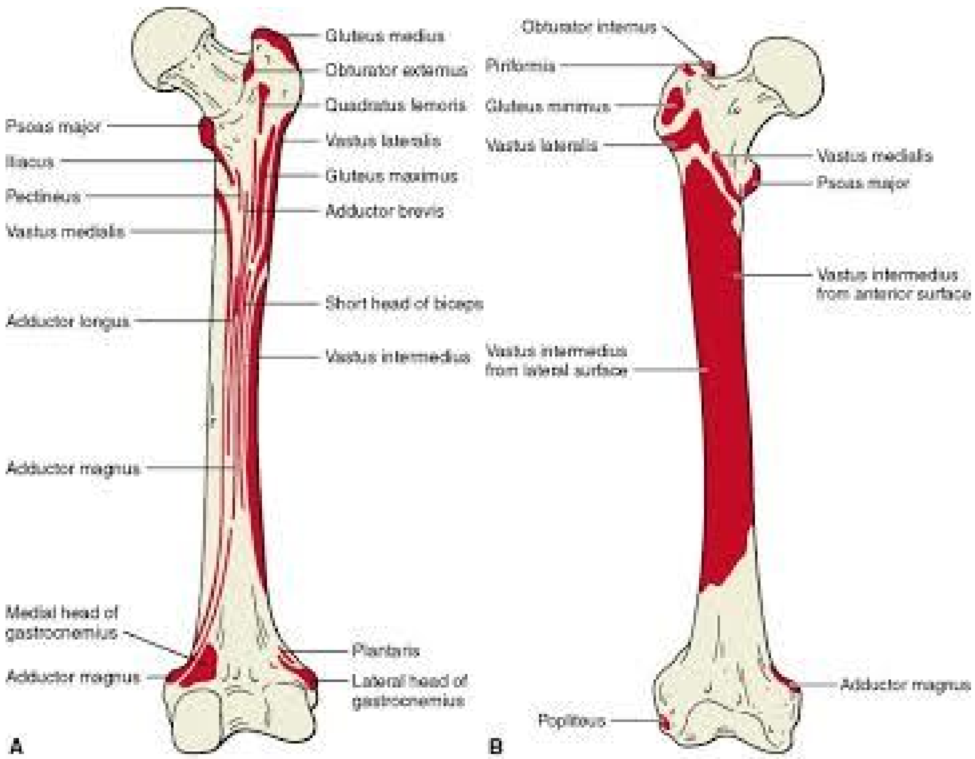
The neck also called collumfemoris is a flattened pyramidal process of bone connecting the head of femur with shaft and forming a wide angle opening medial side. The angle is highest during infancy and reduces with growth. In an adult neck forms an angle of 125° with the shaft and maintains an anteversion of 15°.



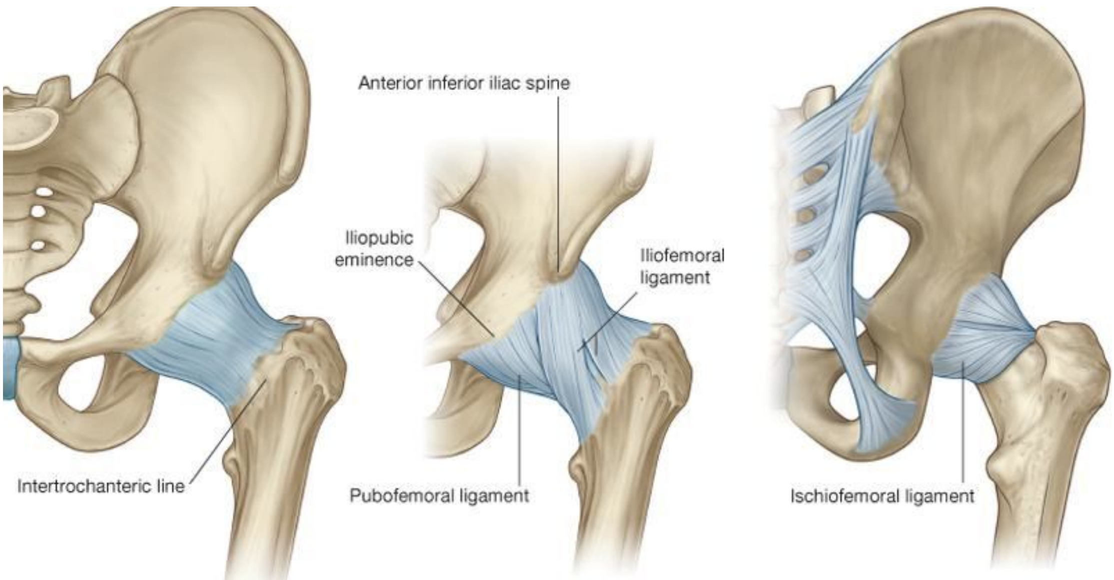
Neck
Head
Greater trochanter
Intertrochanteric line
Lesser trochanter



Head
Neck
Greater trochanter
Trochanteric crest
Gluteal tuberosity
Lesser trochanter
Pectineal line
Linea aspera



Gluteus medius
Obturator externus
Quadratus femoris
Psoas major
Vastus lateralis
Iliacus
Gluteus maximus
Pectineus
Adductor brevis
Vastus medialis
Short head of biceps
Adductor longus
Vastus intermedius
Adductor magnus
Medial head of gastrocnemius
Plantaris
Adductor magnus
Lateral head of gastrocnemius
A
Obturator internus
Piriformis
Gluteus minimus
Vastus lateralis
Vastus medialis
Psoas major
Vastus intermedius from anterior surface
Vastus intermedius from lateral surface
Adductor magnus
Popliteus
B



Anterior inferior iliac spine
Iliopubic eminence
Iliofemoral ligament
Intertrochanteric line
Pubofemoral ligament
Ischiofemoral ligament

The neck shaft angle is less in females because of their wider pelvis.The anterior surface of neck is perforated by numerous vascular channels. Posterior surface is smooth, broader and more concave than anterior. The posterior capsule of the hip joint is attached over the posterior surface nearly 1 cm above the intertrochanteric crest. Superior border of neck is short, thick and ends laterally at greater trochanter.The inferior border is long ,narrow and ends at lesser trochanter.

The neck of the femur is strengthened by calcarfemorale along its concave surface.

GREATER TROCHANTER:

The greater trochanter is a large, irregular quadrilateral eminence with four bordersandtwo surfaces. The lateral surface, which is quadrilateral in form, is rough,convex,broad and is marked by a diagonal impression which serves as a site of attachment for tendon of gluteus medius.The medial surface is of much less extent and presents as a deep impression called trochanteric fossa or digital fossa.This serves as an insertion site for tendon of obturatorexternus,obturatorinternus and gemelli.

Superior border is free,thick and irregular, serves for insertion of piriformis muscle. The inferior border corresponds to line of junction of base of trochanter with body and gives origin to upper part of vastuslateralis. Anterior border is prominent,irregular and affords insertion to gluteus minimus.The posterior border is prominent,appears as a free,rounded edge and bounds the back of trochanteric fossa.

LESSER TROCHANTER:

It is a conical eminence directed backwards and mediallyfrom junction of neck and shaft of the femur. Psoas major is inserted over the apex and medial part of rough anterior surface.

Iliacus muscle is inserted on anterior surface of base of lesser trochanter and the area below it. The smooth posterior surface is covered by a bursa due to the upper horizontal fibres of adductor magnus.

INTERTROCHANTERIC LINE:

This line marks the junction of anterior surface of the neck with shaft of femur. It begins above at the anterosuperior angle of the greater trochanter and is continuous below with spiral line in front of lesser trochanter.

It provides attachment to:

1. Capsular ligament of the hip joint.
2. Upper band of iliofemoral ligament in upper part.
3. Lower band of iliofemoral ligament in lower part
4. Origin to the highest fibresof vastuslateralis from its upper end and
5. Origin to the highest fibres of vastusmedialis from its lower end.

INTERTROCHANTERIC CREST:

This marks the junction of posterior part of neck with shaft of femur. It begins above at posterosuperior angle of greater trochanter and ends at lesser trochanter. The rounded elevation called QUADRATE TUBERCLE, provides insertion to quadratusfemoris muscle.

BLOOD SUPPLY:

An extracapsular arterial ring is formed anteriorly by ascending branch of lateral femoral circumflex artery and posteriorly by medial circumflex femoral artery. The ascending cervical branch from this ring pierce the hip capsule near its distal insertion, becoming the retinacular arteries.There are four main groups of retinacular vessels (anterior,posterior,medial and lateral) of which lateral retinaculargroup supply the major blood supply to femoral head. A subsynovialintracapsular arterial ring enter the femoral head and are at very high risk due to displacement that occurs following any fracture affecting the blood supply to the femoral head resulting in AVN if head is retained.

The artery of ligamentumteres , a branch of obturator artery supply a small portion of femoral head around the fovea capitis.

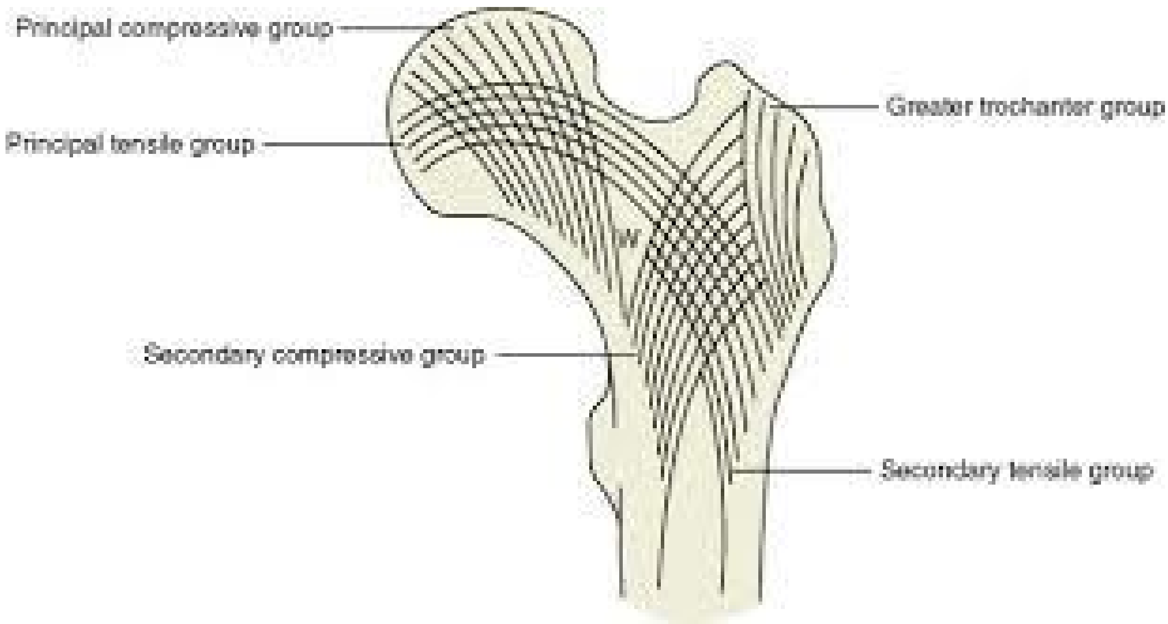
SENSORY SUPPLY:

The hip joint receives innervation from obturator,femoral,sciatic and superior gluteal nerves. Obturator innervates anteromedial part of joint.Anterior capsule gets sensory innervation from femoral nerve.The posterior aspect of joint is innervated by sciatic nerve and posterolateral capsule gets its supply from superior gluteal nerve.

TRABECULAR PATTERN:

The trabecular architecture of the proximal end of femur comprises of 5 distinct groups:

1) Principal compression trabeculae- They run from the weight bearing portion of the femoral head to the region of the calcarfemoris and the medial cortex.
2) Principal tension trabeculae - They begin in the inferior portion of the head and arch across the superior portion ,terminating in the lateral cortex
3) Trochantertrabeculae- They begin in the greater trochanter and end in the lateral cortex
4) Secondary compression trabeculae
5) Secondary tension trabeculae - These are found between primary trabeculae and act as tie beams. The primary tensile and compression trabeculae, resist tensile and compression stress respectively. Trabecular bone is concentrated as thin layer deep to the subchondral bone.


Principal compressive group
Principal tensile group
Greater trochanter group
W
Secondary compressive group
Secondary tensile group

CLASSIFICATION

There is no single classification system till date that has achieved reliable reproducible validity.**Astley cooper** in 1822 proposed a classification system for hip fractures.He has divided into two major groups as intracapsular and extracapsular.

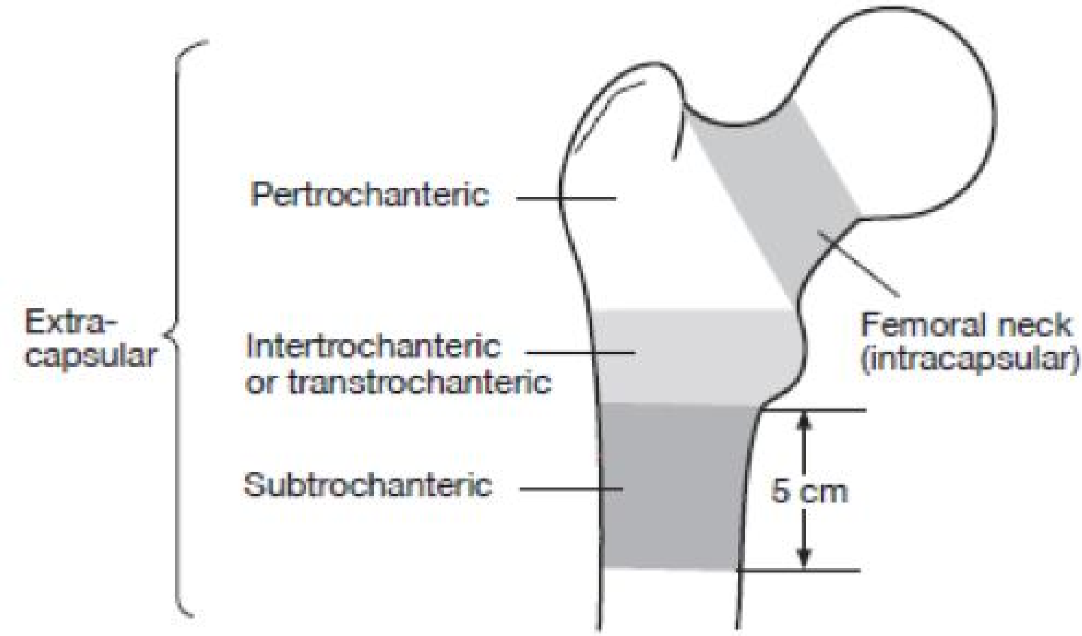
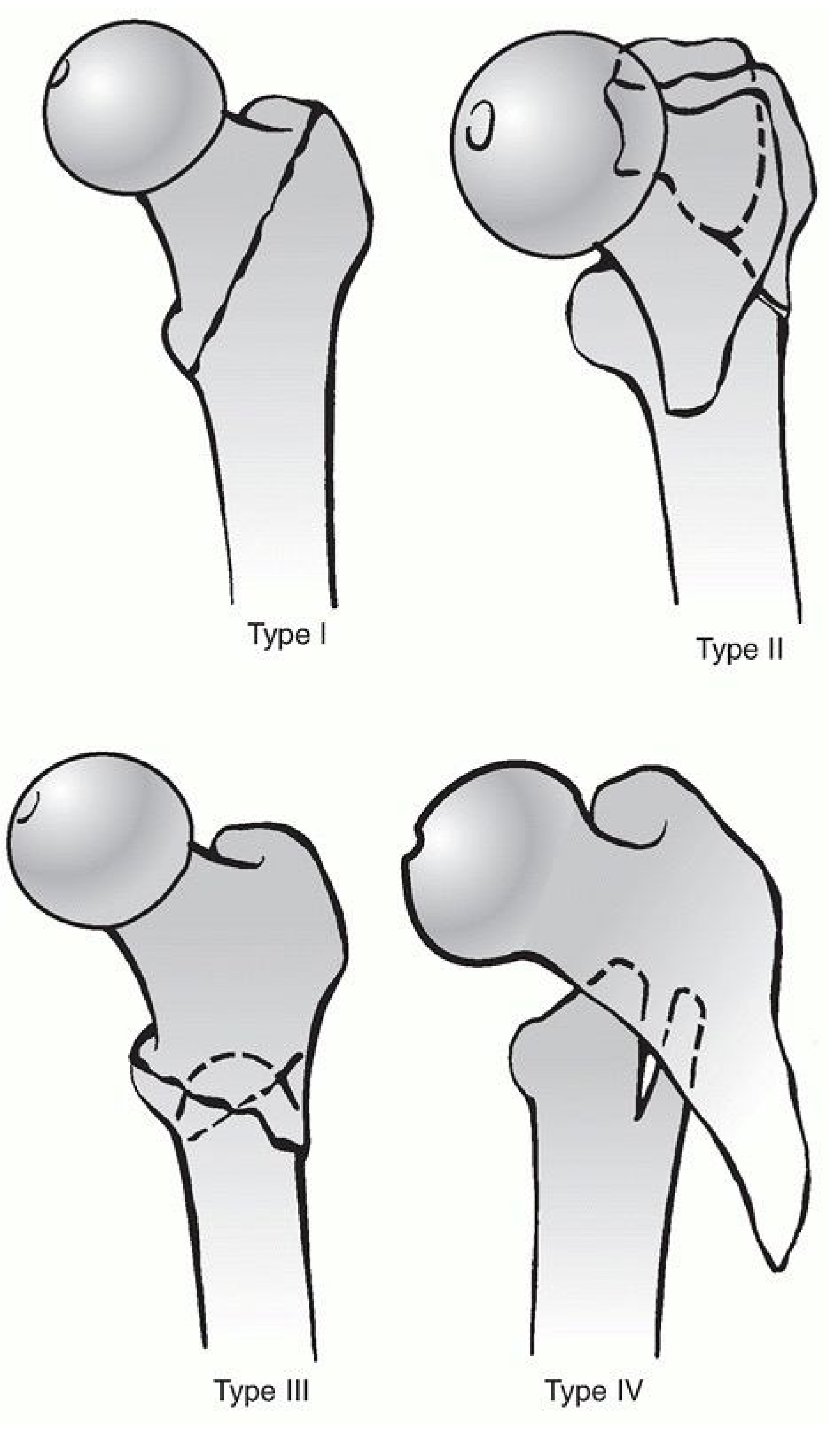


Fig : Classification of Hip fractures.Intracapsular = Femoral neck fractures

Extracapsular = Pertrochanteric,Intertrochanteric and Subtrochanteric fractures

Commonly fractures are described by number of fragments and instability. Presence of certain characteristics like loss of posteromedial buttress, inadequate lateral wall indicate instability.

BOYD AND GRIFFIN CLASSIFICATION:



Boyd and Griffin (1949) classified fractures in the trochanteric area of femur into 4 types.[32] Their classification included all fractures from extra-capsular part of neck to a point 5 cm below the lesser trochanter. Their classification is useful in planning treatment and estimating prognosis.

Type 1: Stable (Two part); with fractures extending along the intertrochanteric line

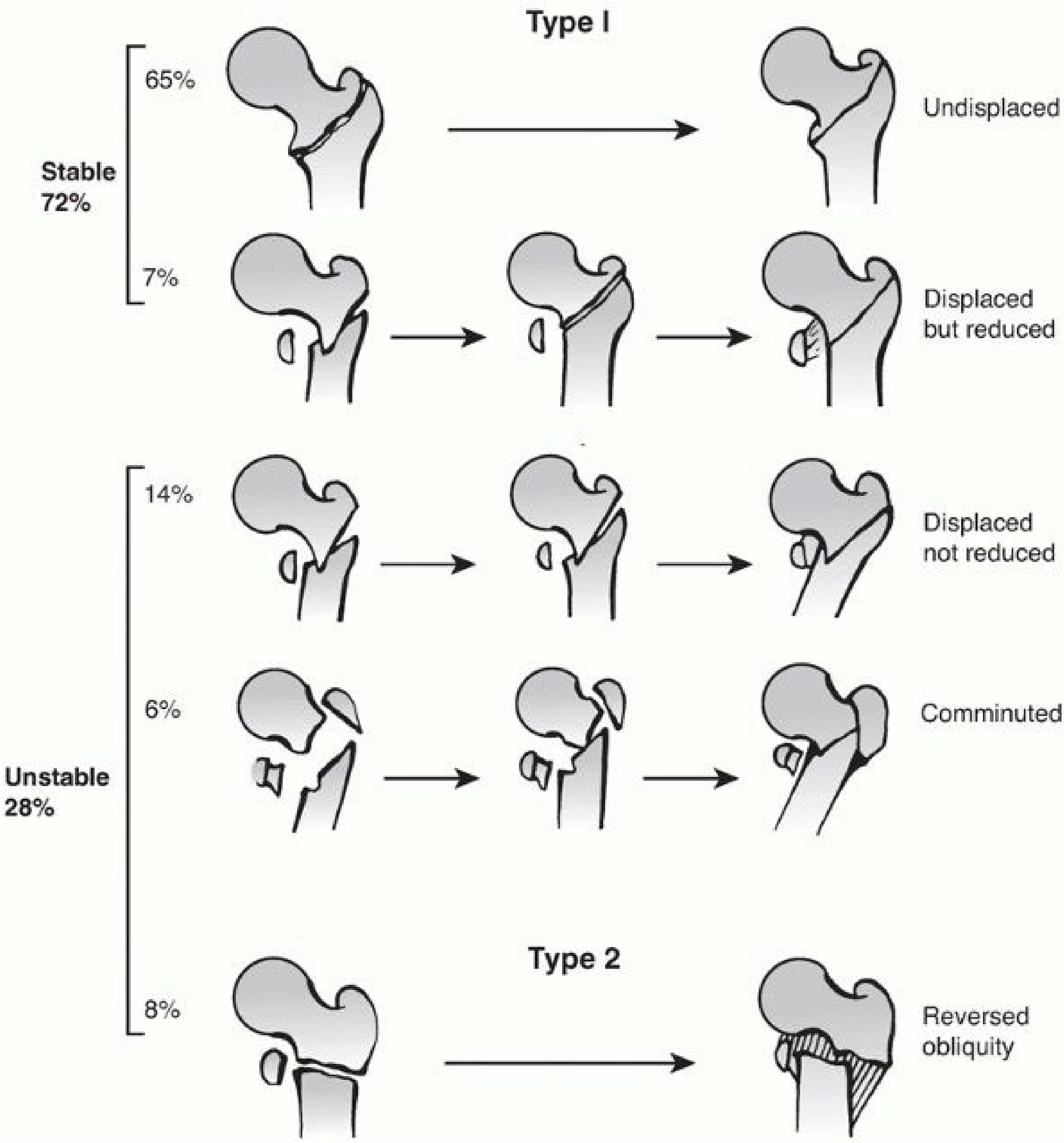
Type 2:Unstable with Posteromedial comminution

Type 3:Subtrochanteric extension into lateral shaft.The term reverse obliquity was coined for these fracture patterns by Wright

Type 4:Subtrochanteric with intertrochanteric extension with fracture lying in atleast two planes.

EVANS CLASSIFICATION:

Evans.E in 1949 presented a way simpler classification based on dividing the fractures into stable and unstable groups.[33]He further divided the unstable into those in which stability could be restored by anatomic or near anatomic reduction and in those in which anatomic reduction would not produce stability.


Type I
Stable
72%
65%
Undisplaced
7%
Displaced
but reduced
Unstable
28%
14%
Displaced
not reduced
6%
Comminuted
Type 2
8%
Reversed
obliquity

TYPE - 1 :

The fracture line extends upwards and outwards from the lesser trochanter and there are 4 sub divisions.

In the first group, comprising 65% of all cases, the inner cortical buttress has never been disturbed. There is no displacement and fractures unite in perfect position.

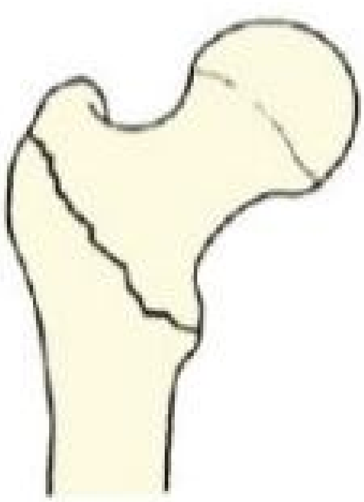
In the second group, simple overlap of the inner cortical buttress can be reduced by manipulation and the fracture thus becomes stable.

In the third and fourth group, there is unreduced overlap or destruction of this cortical buttress and coxavara deformity is to be expected.

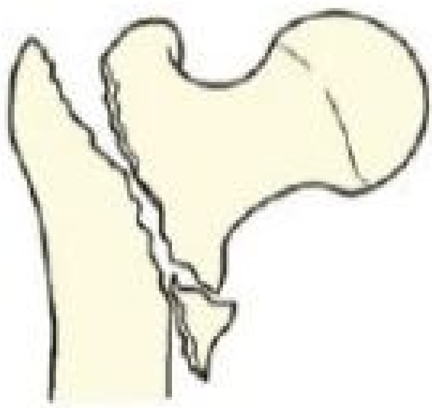
TYPE - 2 :

The obliquity of major fracture line is reversed, that is it extends downward and outward from lesser trochanter. There is marked tendency to inward displacement of the femoral shaft but this does not affect the ultimate function.

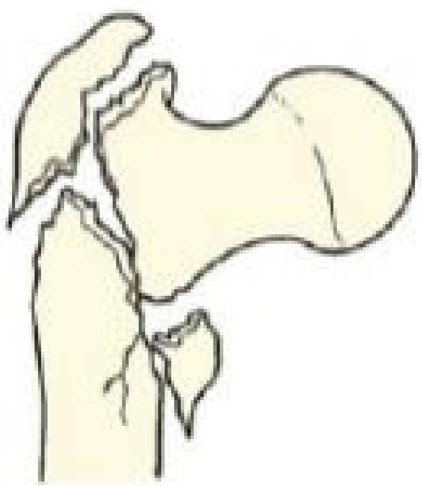
KYLE CLASSIFICATION



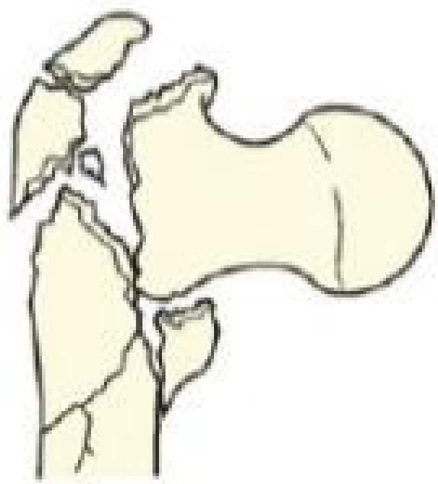
Type I



Type II



Type III



Type IV

KYLE CLASSIFICATION[34]

TYPE- 1 (STABLE):

Two part fracture that is undisplaced

TYPE-2 (STABLE):

Fractures that are displaced into varus with a smaller lesser trochanteric fragment, but with an essentially intact posteromedial cortex

TYPE-3 (UNSTABLE):

Four part fractures that are displaced into varus with posteromedial cortical communition and a greater trochanteric fragment.

TYPE-4 (UNSTABLE):

Type 3 fracture with subtrochanteric extension

TRONZO CLASSIFICATION

TRONZO CLASSIFICATION :

Tronzoin 1974 proposed a classification based on the reduction potential.[46] According to him trochanteric fractures are divided into 5 types and each type requires a specific mode of reduction and fixation with a nail plate assembly.

TYPE - 1 :

Incomplete trochanteric fractures.

TYPE - 2 :

Non - comminuted trochanteric fractures with or without displacement in which both trochanters are fractured.

TYPE - 3 :

Comminuted fractures in which the lesser trochanteric fragment is large. The posterior wall is exploded with the back of the inferior neck already displaced in the medullary cavity of the shaft fragment. These are unstable fractures. A `variant of type 3 fracture also has the greater trochanter fractured off and separated.

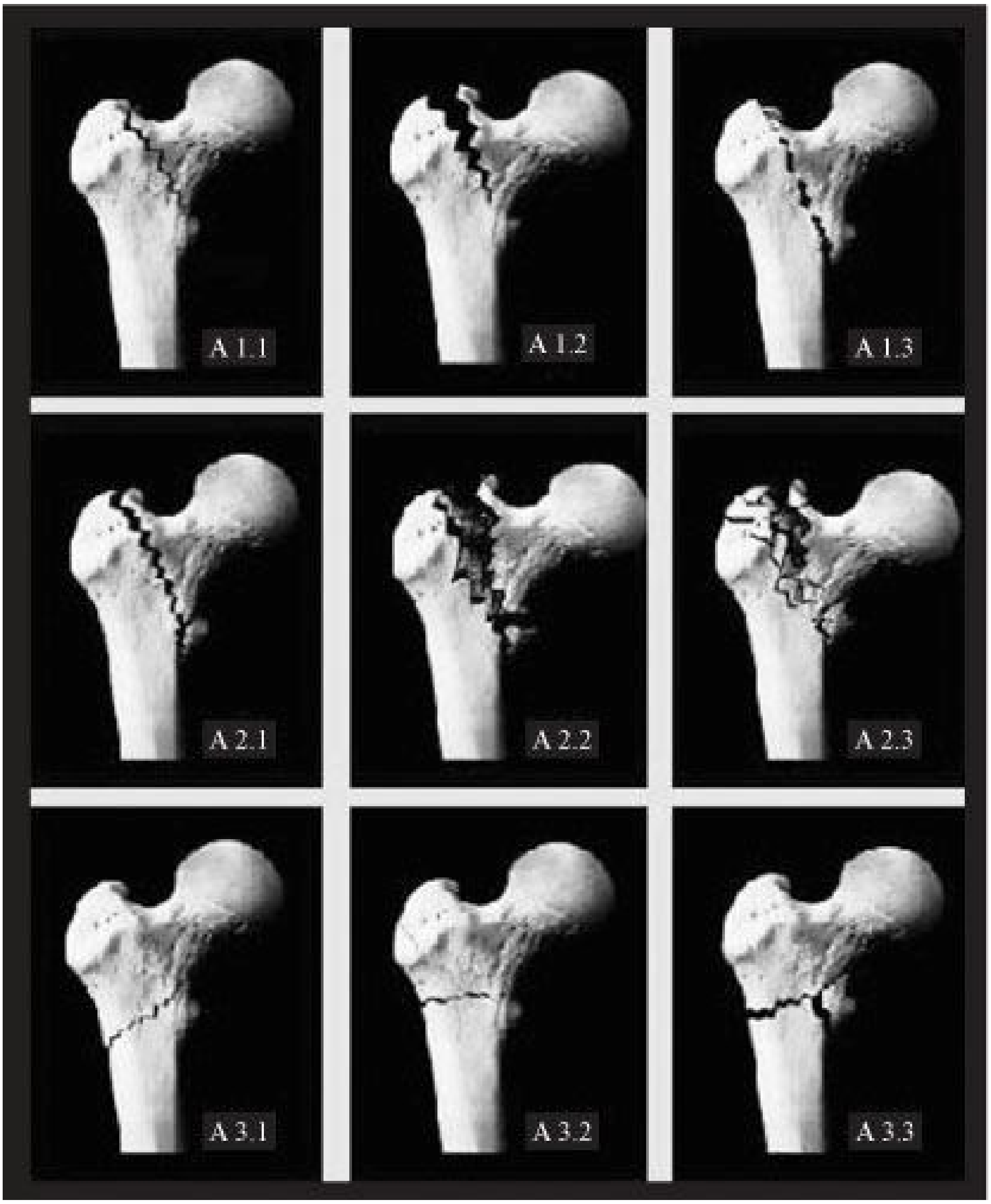
TYPE - 4 :

Comminuted trochanteric fracture with disengagement of the two main fragments. Again these are unstable with the posterior wall exploded, but the spike of the neck fragment is displaced outside of or medial to the shaft.

TYPE - 5 :

Trochanteric fractures with reverse obliquity. These are uncommon.

AO CLASSIFICATION



RAMADIER CLASSIFICATION

A) Cervico-trochanteric fracture with fracture line at the base of neck

B) Simple pertrochantericfracture,Often lesser trochanter is broken off.

C) Complex pertrochantericfracture;greater trochanter is separated from femoral shaft

D) Pertrochnateric fracture with valgus displacement

E) Pertrochanteric fracture with intertrochanteric fracture line.

F) Trochantero-diaphyseal fractures

G) Subtrochanteric fracture.[45]

AO CLASSIFICATION:

Muller in 1990 has classified the trochanteric fractures into stable andunstable types.[35]The stable trochanteric fractures have an intact medial buttress comprising 70% of the cases. The unstable types have large posterior fragment in addition to the medial fragment. They emphasize that for stability, the medial and posterior cortex should be intact. In treatment of unstable trochanteric fractures medial buttress should be reconstructed before fixation with an implant.

TYPE A1:

Pertrochanteric simple (the typical oblique fracture line extending from greater trochanter to medial cortex; lateral cortex of the greater trochanter usually remains intact - two fragments)

A1.1 : along the intertrochanteric line

A1.2 :through the greater trochanter

A1.3 : below the lesser trochanter

TYPE A2 :

Pertrochantericmultifragmentary (the typical oblique line extending from greater trochanter to medial cortex ; lateral cortex of the greater trochanter usually remains intact - separate posteromedial fragment).

A2.1 : with one intermediate fragment.

A2.2 : with several intermediate fragments.

A2.3 : extending more than 1 cm below the lesser trochanter.

TYPE A3 :

Intertrochanteric fracture line extends across both medial and lateral cortices.

A3.1 : Simple oblique (reverse obliquity pattern).

A3.2 : Simple transverse.

A3.3 :Multifragmentary.

KULKARNI CLASSIFICATION:

Using Evan-Jansen's and AO/OTA classification and by adding new varieties described by **Gotfried and Kyle, Kulkarni et al.** have presented a new treatment oriented classification in 2006.[36]

Type 1A : Stable undisplaced , 2 stable piece fracture

Type 1B : Displaced , reducible , stable , 2 part fracture

Type 1C : Displaced but reducible, stable fracture type with small piece of lesser trochanter.

STABLE

2 Part Undisplaced TYPE IA

2 Part displaced stable TYPE IB

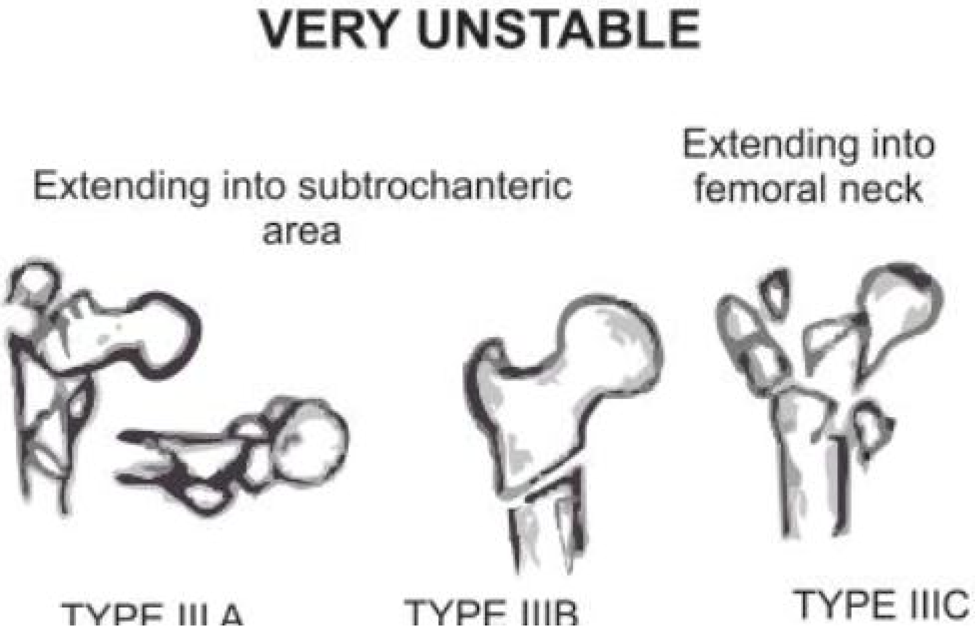
Stable with lesser trochanteric piece TYPE IC

UNSTABLE

3 piece Unstable TYPE II A

4 piece unstable TYPE IIB

Shattered lateral wall TYPE IIC



UNSTABLE:

Type IIA:Unstable 3 piece fracture with large posteromedial fragment of lesser trochanter.

Type IIB: 4 Piece fracture

Type IIIC: Shattered lateral wall

VERY UNSTABLE:

Type IIIA: Trochanteric fracture with extension into subtrochanter

Type IIIB: Reverse oblique

Type IIIC: Trochanteric fracture with extension into femoral neck area

PRINCIPLES OF MANAGEMENT

Low energy falls from standing height is the most common mode of injury for these fractures.These fractures are commonly seen in patients older than 50 years of age.High energy fractures are relatively rear and if present are common in men less than 40 yrs of age.**Cummings**in 1989 hypothesized that four conditions were correlated for fall to cause a hip fracture:[38]

1) Faller will be oriented to impact around hip
2) All the protective responses must fail
3) Lost soft tissues should absorb less energy than necessary to prevent fracture to occur.
4) Residual energy of fall applied to proximal segment must exceed its original strength.

This concept applies primarily for strategies in preventing hip fractures.Fall with rotational component is more commonly seen with extracapsular fractures.

In some instances patients also present with distal radius , Proximal humerus and minor head injuries associated with low energy falls. High energy fractures are commonly associated with ipsilateral extremity trauma,pelvis fractures and head injuries.Premorbid diseases may also coexist with fracture diagnosis.Syncopal attacks resulting in fall should focus attention on neurological and cardiovascular disease states.Any primary neoplastic or metastatic disease may reveal preceding hip pain and subsequent fall results in fracture.

HISTORY AND PHYSICAL EXMAINATION

Patients present with history of pain and inability to weight bear over the affected lower limb following a fall or other injury.Pain is localized to proximal thigh region and is exacerbated by either passive or active attempts of hip movements.A displaced trochanteric fracture shows a classical findings of limb shortening and external rotation deformity in resting position when compared with contralateral extremity. Pain with axial compression on the hip has high correlation with occult fracture.Auscultation Lippmann test is a sensitive method to detect any occult fractures of pelvis or proximal femur in 1939.[40] By placing stethescope bell on symphysis pubis and tapping on patella of both lower limbs, variations in sound conduction through hip and pelvis from patella result when there is any discontinuity.A decrease in tone or pitch implies fracture within arc of bone.

High risk potentially preventable complications such as deep vein thrombosis, pulmonary embolism, anti-coagulation medications , immune deficiency disorders , angina or Cerebrovascular accidents ,atherosclerotic disease ,any active infection are to be evaluated.

IMAGING AND OTHER DIAGNOSTIC MODALITIES

Plain radiographs of AP view of pelvis , AP and cross table lateral view of the affected hip are usually asked for diagnosis and preoperative planning. **Koval KJ el al.** in 2008 has said that traction views are helpful in comminution and high energy fractures for determining implant selection.[41]Subtrochanteric fractures require full length femur AP and lateral radiographs for implant length selection.If long nail implant is selected , AP and lateral radiographs of affected proximal femur to knee are required with attention to femoral bow and medullary canal diameter.Traction with internal rotation views may benefit preoperatively for aiding in selection of definitive internal fixation.[41]

Rizzo PF in 1993 stated that CT and MRI are required in diagnosis of a nonobvious and atypical fractures in high energy trauma patients.[42,43]In many institutions fluoroscopic C-arm views in the operating room has reduced the need for preoperative lateral radiographs.

STABLE INTERTROCHANTERIC FRACTURE:

A) The fracture runs from the greater trochanter obliquely downwards and medially to exit just above the lesser trochanter. A good portion of the calcar is attached to the proximal fragment anteromedially. Quite commonly there is an avulsion fracture of the lesser trochanter. As a rule the distal fragment is in external rotation. Rarely, the inferomedial spike of the proximal fragment is impacted into the metaphysis of distal fragment.

B) An avulsion does not result in instability because it does not weaken the medial buttress.

UNSTABLE INTERTROCHANTERIC FRACTURE:

An unstable intertrochanteric fracture has characteristics that predispose to displace even after reduction and fixation has been achieved. If displacement is minor, it results in minimal limb shortening. Severe displacement, however can cause a well placed fixation device to cut out of femoral head and damage the acetabulum. **Litchblau** in 2008 also added that displacement can also result in malunion, nonunion and failure of fixation device.[37]Occasionally the fracture has a reverse course beginning laterally and distally and running upwards and medially. Medially it exits above the lesser trochanter. Commonly it is associated with a fracture of the greater trochanter.

Unstable intertrochanteric fractures can often be recognized during physical examination.An intertrochanteric fracture that presents with an severely shortened or internally rotated limb is an unstable fracture.Radiographs will certainly show displacement, comminution and reverse obliquity.

Risk factors for instability in trochanteric fractures include:[37]

1) Loss of medial buttress : This occurs in almost all 4 part fractures and in those 3 part fractures that have large lesser trochanter

fragments.

2) Markedly displaced fractures : They are identified radiographically by loss of contact of any original surface on proximal segment with its corresponding surface on distal segment.The reason for instability produced by marked displacement is combination of severe soft tissue damage with loss of stability provided by original bone contact.Wide gapping at the fracture site, which reduces hen the limb is internally roatated is not considered as marked displacement.
3) Reverse obliquity fractures : The fracture line runs from proximal medial to distal lateral instead of the usual pattern.Coronal plane fractures are also seen in this category.
4) Severe osteoporosis : Singh index of $\leq$ 3 warrants concern
5) Comminution at fracture site: Sometimes missed in preoperative radiographs , but can be noted on the lateral radiographs taken in the operating room.[37]

According to **Watson et al.** in 1998 ,Stable trochanteric fractures are commonly treated with sliding hip screw fixation with failure rates less than 2%.[44]The treatment of unstable trochanteric fractures is more controversial and has multiple got multiple modalities of treatment with no clearcut guidelines.

HISTORY AND EVOLUTION OF TREATMENT

Internal fixation in treatment of intertrochanteric fractures has gained world wide acceptance.

The general approach towards these fractures consisted of various methods of closed reduction,traction and immobilization.

In 1800s pott and cooper advocated supporting thigh in flexion,early mobilization from bed rest to chair and then to ambulation with support was the primary goal in the treatment of these fractures.They have proposed benign neglect of fracture in attempt to save life over limb.[4] Hugh Owen Thomas from Liverpool in 1890 advocated prolonged immobilization and bed rest.[5]

Although, **Von Langenbeck** first reported an open reduction and internal fixation of a fractured hip in 1878 [6],it was **Smith Peterson's** refinement of the surgical approach and introduction of the Triflangednail 40 years later that operative treatment became a better practical alternative.[7] The problems and disadvantages with fixation by wires, threaded wire pins and screw apparatus has rapidly sent them out of practice in treatment of these fractures. Whitman in 1902 advocated reduction, stabilization with traction, internal rotation and abduction to restore the anatomy instead of benign neglect.[8]The limb was maintained in long leg spica cast to maintain reduction.

In 1937, **Thornton** devised a plate attachment to the S.P. Triflanged nail so that trochanteric fractures could be betterly fixed.[9] In 1941, **Jewett** developed a single piece angled nail. The Jewett nail with a few minor structural changes was proven acceptable.[10] A simplification in design in the form of a "V" nail was introduced in 1944 by **Neufeld**.[11,12]

FIG: SMITH-PETERSON NAIL

FIG: JEWETT NAIL

In the same year **Austin Moore** designed his blade plate for trochanteric fractures but its use was short lived, for this fracture because of the superiority of other nails. In 1947, McLaughlin engineered a variable angle nail plate, the advantage of which was the ease of adaptation of plate to the femoral shaft after the nail has been driven inside.

In 1938, **Godey - Moreira** reported 10 fractures treated with a cannulated "stut bolt screw" which impacted the fragments. Perfect results were obtained in 7 of the 8 patients followed.

FIG: SMITH PETERSON NAIL AND MC LAUGHLIN SIDE

Richardson who invented trochanteric buttress plate at Campbell clinic was first reported by **Boyd and Griffin** in 1949 to prevent the medialization with neufeild plate in unstable fractures.[13] Boyd also reported few refinements to the buttress technique by adding screw fixation into the trochanter.[14]

In 1955, **Schumpelich and Jantzen** described the use of a Sliding Screw, the design which they attributed to Ernst Pohl.[7]

Fig: RICHARDS SCREW

In 1964, **Clawson** reported on treatment of trochanteric fractures using Sliding hip Screw and plate.The device was developed independently at Richards' manufacturing company. Clawson made further modifications and in its current form the device is known as Richards' Compression Hip Screw.[15]

In recent years, the Sliding Hip Compression Screw system (Richards, Zimmer, etc.) has become a widely accepted method of internal fixation for trochanteric fractures.

Valgus osteotomies were popularized by **Dimon and Houston, Harrington, Sarmiento** and others in 1960's to increase the stability of unstable fractures.[16,17,18] Prospective studies, meta-analysis compared the results of sliding hip screw and osteotomies has showed no functional improvement with osteotomy and infact a higher risk of blood loss.[19,17,20,21]

This stabilisation of trochanteric fractures by remotely introduced medullary implants was first recommended by **Lezius, Kuentscher** and later **Simon Weidner** and especially **Ender** advanced in this direction and refined this method.[22]

The Percutaneous compression plating system[23,24] by the **Gotfried** in 1980 is a new method of managing trochanteric fractures in which it is composed of a plate, two telescoping neck screws and three shaft screws. The plate is specially designed to pass through soft tissues and to glide along the femoral shaft. This system permits percutaneous screw fixation and fracture site compression.

CH Marsh in 1983 has proposed the use of enders nail in management of intertrochanteric fractures.Early fixation failure , leg shortening and external rotation deformities due to uncontrolled fragmentary collapse has questioned their use in unstable intertrochanteric fractures.[47]

In 1980's to 1990's **Medoff**introduced biaxial compression hip screw for unstable intertrochanteric fractures.[25] This was proven effective to minimize implant failure but with increased limb length discrepancy.[26,27]

In 2002 **Janzing HM,[28]Huben B,J** stated that percutaneous compression plating system trochanteric fractures is a minimal invasive technique with reduced operative time and postoperative pain than fixation with sliding hip screw.

In 2003 **Hardy D C[29]**stated that a slotted intramedullary hip screw nail reduces the proximal mechanical unloading on the femur.

In 2006 **N K Karn[30] ,G K singh** proposed external fixator as a treatment modality for intertrochanrtic fracture. In their study they stated that less amount of operative time, minimal blood loss were the potential advantages with this line of management.

In 2007**YechielGotfried** proposed that integrity of lateral femoral wall in intertrochanteric hip fractures is a predictor for reoperation in trochanteric fractures.[31]

The long list of devices that have been used to stabilize these type of fractures is a testimonial to the fact that many did not do well.Thus there is continuing efforts being made to improve the design and materials of fixation devices.

SURGICAL OPTIONS FOR TROCHANTERIC FRACTURES

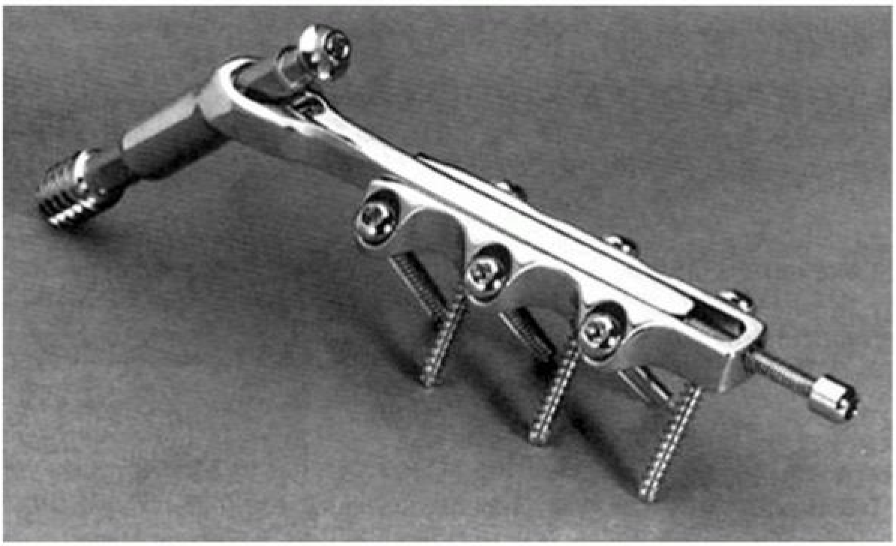
Surgical options for trochanteric fractures included plate screw constructs, nail or screws for head fixation , nail constructs with screws , external fixation devices and arthroplasty.

Plate constructs are grouped into four functional types:

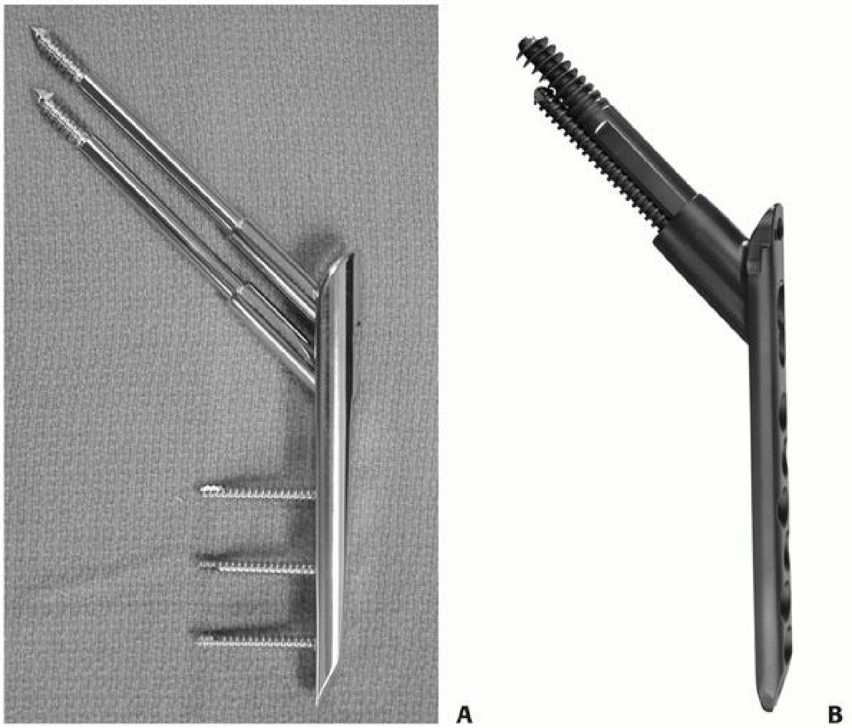
1) Impaction class:
    a) Blade plates
    b) Fixed angle nail plate devices
2) Dynamic compression class :
    a) Standard sliding hip screws
3) Linear compression class : Multiple head fixation components controlling translation and rotation but allow linear compression.
    a) Gotfried PCCP
    b) InterTAN CHS
4) Hybrid locking class : Most stable type of fixation.Initially provides compression for fracture reduction with multiple fixation components followed by locking screw to prevent further axial compression.
    a) Proximal femur locking plates.

Fixed angle plating are commonly used for corrective osteotomies instead of primary treatment of hip fractures.**Chinoy et al.**[21] in their meta-analysis of 2855 patients compared accurately fixed nail plate constructs with sliding implants.They concluded that there there was increased risk of cutout (13% Vs. 4%) , implant breakage (14% vs. 0.7%) , Noninion (2% vs. 0.5%) and reoperation (10 % vs. 4%) for fixed angle nail plates in comparison with sliding implants.

COMPRESSION HIP SCREW



MEDOFF SLIDING PLATE



A:PERCUTANEOUS COMPRESSION DEVICE

B: INTERTAN CHS PLATE

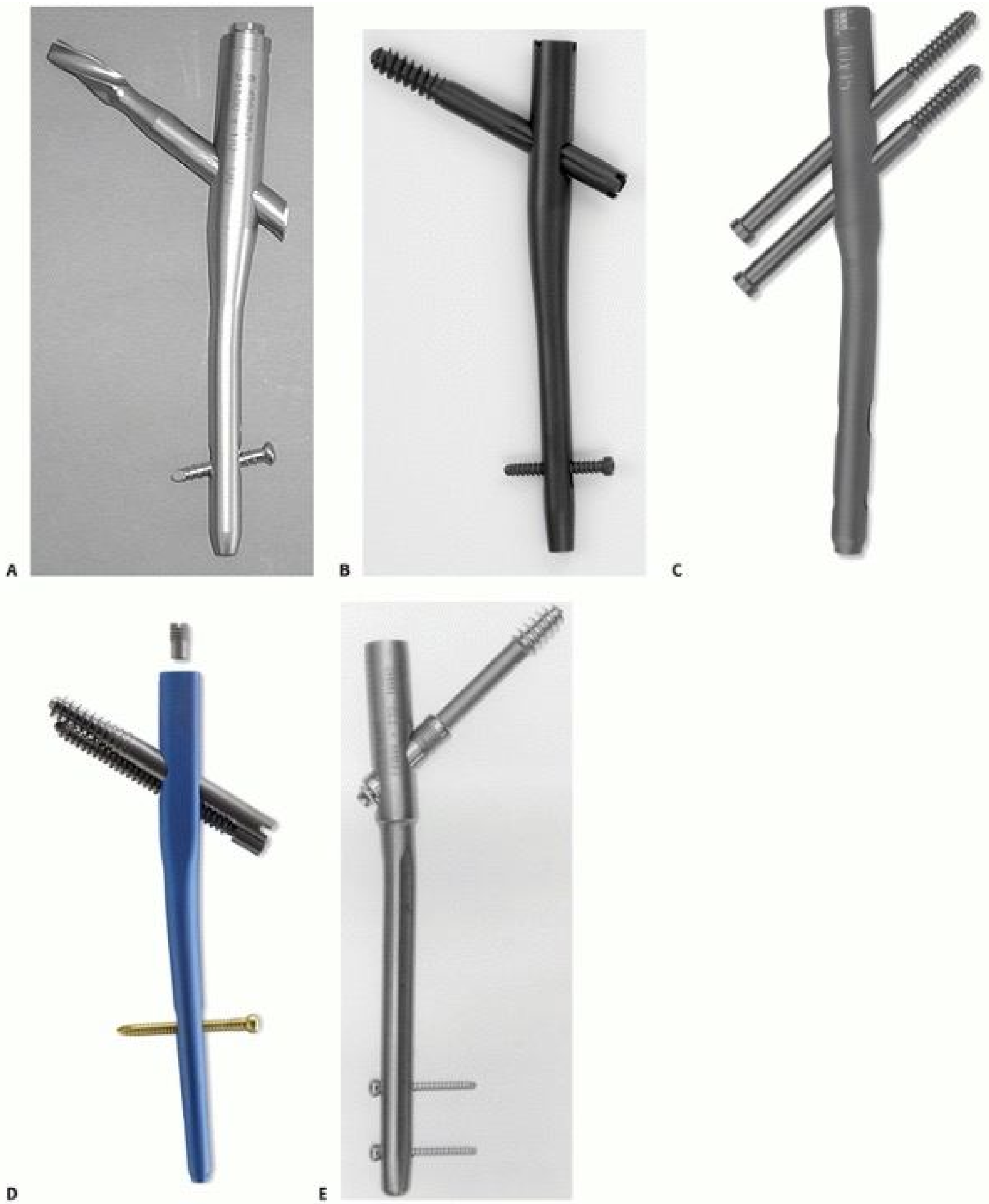
HYBRID LOCKING PLATE SYSTEM

CEPHALOMEDULLARY DEVICES:

These devices are inserted through piriformis fossa, lateral greater trochanter and medial greater trochanter. The femoral head portion of construct consists of one or more screw and blade device interlocked with nail component. Most commonly indicated in pertrochanteric and subtrochanteric fractures. In piriformis entry nail the shaft component is straight in AP plane and in trochanteric entry nail the shaft component is laterally angulated proximally.In 2008 Russel classified cephalomedullary nail constructs in order of invention as :[48]

1) Impaction class or Y nail class
2) Dynamic compression (or) Gamma class – Large head nail component with a single large lag screw.
3) Reconstruction class with a smaller head diameter and using two lag screws which are independent of each other
4) Integrated class : Provides linear compression at fracture site.Dveloped by russel and sanders.

Class	Examples	Failure Modes
Impaction	Y-Nail, TFN	Medial penetration
Dynamic compression	Gamma, IMHS	Cutout
		Peri-implant failure with short designs
Two-screw dynamic compression	Reconstruction	Z-effect
Linear compression integrated	InterTAN	Unknown



A. Short trochanteric fixation nail.(TFN)

B. Short gamma 3 intramedullary nail

C. Short trochanteric antegrade nail

D. Short InterTAN cephalomedullary nail

E. Short intramedullary hip screw (IMHS)

MATERIALS AND METHODS

Retrospective study:

All intertrochanteric fractures operated in PSG hospitals, Department of orthopaedic surgery, Coimbatore by sliding hip screw fixation from January 2011 to December 2013.

Prospective study:

Patients with intertrochanteric fractures admitted in PSG Hospitals affiliated to PSG institute of medical sciences and research between May 2014 to Aug 2015 treated by sliding hip screw.

Inclusion criteria:

1. All Intertrochanteric fractures treated with sliding hip screw fixation.
2. Patients willing for treatment and given written informed consent.

Exclusion criteria:

1. Pathological fractures
2. Infection
3. Treated after 3 weeks of trauma.
4. Patients medically unfit for surgery.
5. Compound fractures associated with vascular injuries, ipsilateral femoral shaft fractures and pelvic fractures.
6. Patients not willing for treatment.
7. Technically poor surgeries.

Type of study:

Retrospective and prospective.

Methodolgy:

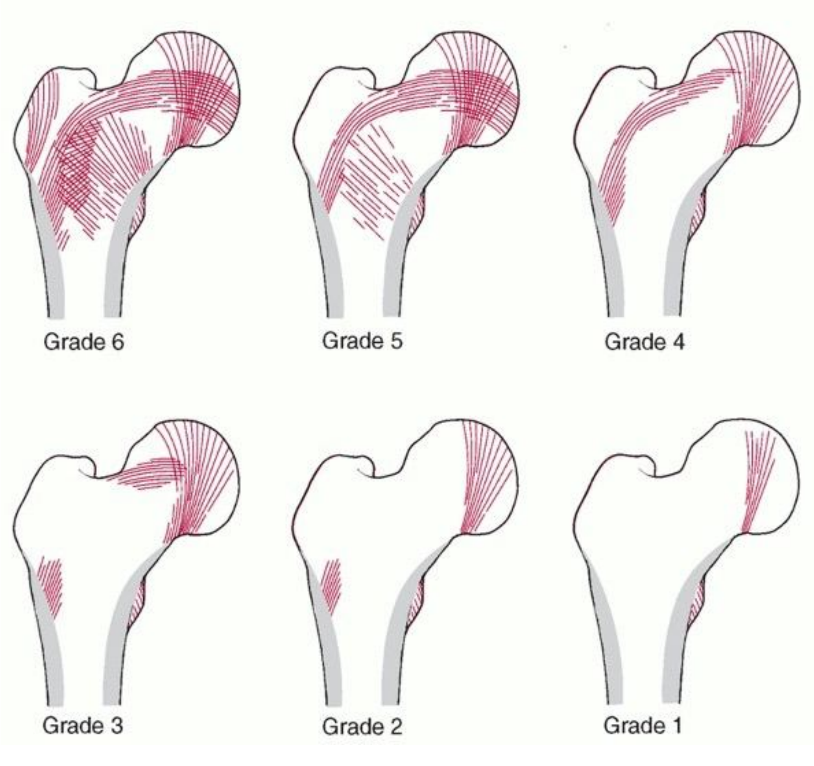
Local factors such as loss of medial buttress, displacement, reverse obliquity, osteoporosis ,comminution at fracture site , lateral wall thickness were assessed by using preoperative radiographs. General medical status was assessed using ASA grading. Fracture reduction was also assessed in postoperative radiographs.

The loss of medial buttress implies that lesser trochanter will be a separate fragment and is most commonly seen in 4 part fracture pattern and in 3 part fractures with large lesser trochanter. In cases where the medial buttress was found intact it was given a score of 0 and in cases where there is loss of medial buttress it was given a score of 1.

Displacement is identified radiographically by loss of contact of any original surface on proximal segment with its corresponding surface on distal segment.In cases where there is contact between proximal and distal fracture fragments it is called as an undisplaced fracture.Whenever there is < 1cm distance between thefracture fragments it is said as minimally displaced fractures and whenever there is > 1 cm gap between any two fracture fragments it is said as grossly displaced fractures. Undisplaced fractures were given a score of 0,minimally displaced fractures were given a score of 1 and in grossly displaced fractures a score of 2 was given.

Reverse obliquity fracture pattern : The fracture line runs from proximal medial to distal lateral instead of the usual pattern.In cases where this kind of pattern was seen a score of 1 was given and in other fracture patterns a score of 0 was given.

Osteoporosis assessment was done by using singh index from true AP projection of intact proximal femur. Grade 3 and below were considered as osteoprotic bones and it is identified by thinned trabeculae with break in principal tensile group.All osteoporotic bones were given a score of 1 and non osteoporotic bones were given a score of 0.



Comminution at fracture site is defined by more than two fracture fragments around the trochanteric region. Presence of comminution at fracture site was given a score of 1 and for 2 part trochanteric fractures where there was no comminution , hence score of 0 was given.

Lateral wall thickness is defined as distance in mm from a reference point below the innominate tubercle of greater trochanter , angled at 135* upwards to the mid point between the two cortex lines. Lateral wall thickness of < 20.5 mm was given a score of 1 and if thickness is > 20.5 mm score of 0 was given.

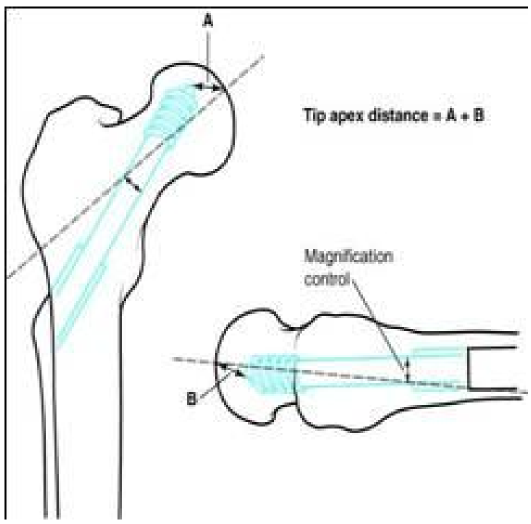
General physical status of the patient is assessed by using ASA grading. For a normal healthy patient a score of 0 was given and according to the existing co-morbidities points 1, 2 3 were given.

ASA Classification		Examples:
ASA I	A normal healthy patient	Healthy; no smoking, no or very minimal drinking.
ASA II	A patient with mild systemic disease	Smoker; more than minimal drinking; pregnancy; obesity; well controlled diabetes, well controlled hypertension; mild lung disease.
ASA III	A patient with severe systemic disease, not incapacitating	Diabetes, poorly controlled hypertension; distant history of MI, CVA, TIA, cardiac stent; COPD, ESRD; dialysis; active hepatitis; implanted pacemaker; ejection fraction below 40%; congenital metabolic abnormalities.
ASA IV	A patient with severe systemic disease that is a constant threat to life	Recent history of MI, CVA, TIA, cardiac stent; Ongoing cardiac ischemia or severe valve dysfunction; implanted ICD; ejection fraction below 25%.
ASA V	A moribund patient who is not expected to survive without the operation	Ruptured abdominal or thoracic aneurism; intracranial bleed with mass effect; ischemic bowel in the face of significant cardiac pathology..
ASA VI	A patient who has already been declared brain-dead and whose organs are being removed for transplant.	
The addition of an 'E' indicates emergency surgery.		

Reduction is assessed by post-operative radiographs by amount of displacement and neck shaft alignment.Reduction is divided into good, acceptable and poor. A good reduction had normal / slightly valgus neck shaft angle and displacement of < 4mm.Acceptable reduction met the requirement of either alignment or displacement but not both.Poor reductions met neither criteria.

Tip-apex distance:

It is the sum of distances from the tip of lag screw to apex of the femoral head on both AP and lateral radiographs.The recommended tip apex distance to reduce the failure was 25 mm.In this study Tip apex distance is measured only for a limited sample.



We have devised a scoring system to assess the outcome of trochanteric fractures. The scoring variables are given below.

1)Loss of medial buttress:

Yes-01

No- 00

2)Displacement:

Undisplaced: 00

Minimally displaced: 01

Grossly displaced: 02

3)Reverse obliquity:

Yes:01

No: 00

4)Osteoporosis:

Yes:01

No: 00

5)Comminution at fracture site:

Yes:01

No: 00

6)lateral wall thickness:

> 20.5mm:00

< 20.5 mm:01

Post-operative:

Reduction:

Good:00

Acceptable:01

Poor:02

In this study all the above variables were assessed with outcome both independently and in combination. Follow up radiographs were taken with a minimum period of 2 months and the outcome was assessed.

Outcome variables:

1) United with no collapse
2) Collapsed but united
3) Fracture failure.

Statistical analysis:

The data are reported as the mean +/- SD or the median, depending on their distribution. The differences in quantitative variables between groups were assessed by means of the unpaired t test. Comparsion between groups was made by the Non parameteric Mann - whitney test. ANOVA was used to assess the quantative variables. A Chi Square test was used to assess differences in categoric variables between groups. A p value of <0.05 using a two-tailed test was taken as being of significance for all statistical tests. All data were analysed with a statistical software package .(SPSS, version 16.0 for windows).

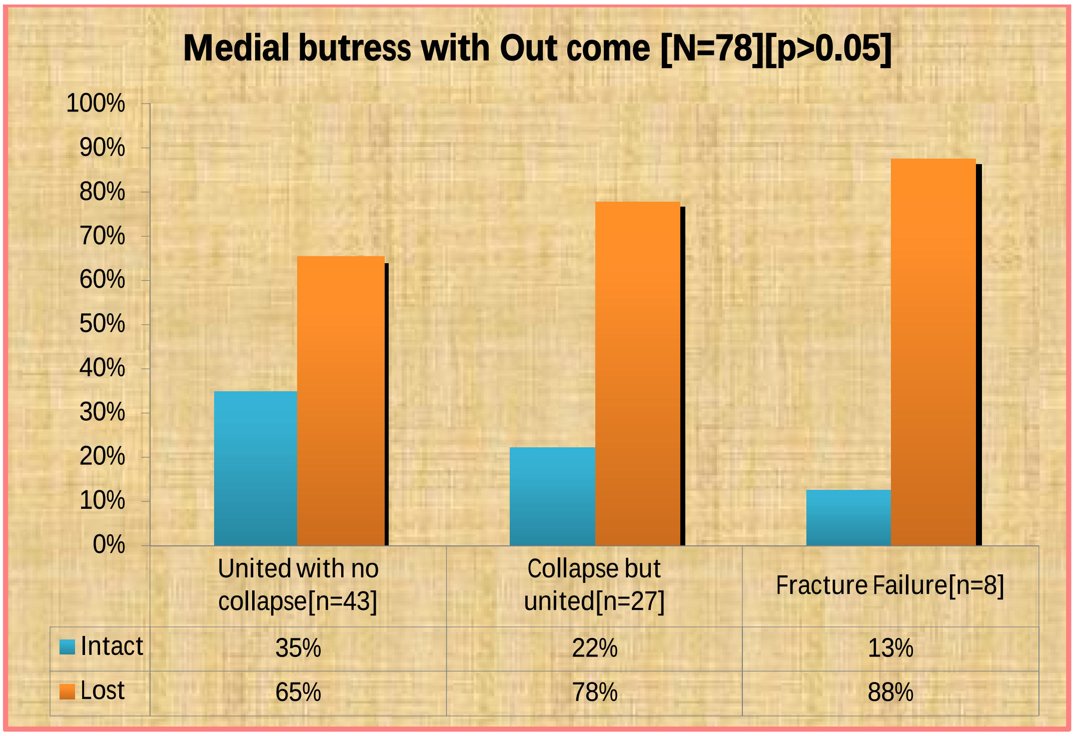
RESULTS

Loss of medial buttress:

In this prospective and retrospective study a total of 78 patients were assessed.Preoperative AP radiographs of pelvis was taken and all the patients were treated by sliding hip screw fixation. Postoperatively follow up radiographs were taken and outcome was assessed. All preoperatively assessed variables were analysed with the outcome variables independently and in combination.

Loss of medial buttress with outcome

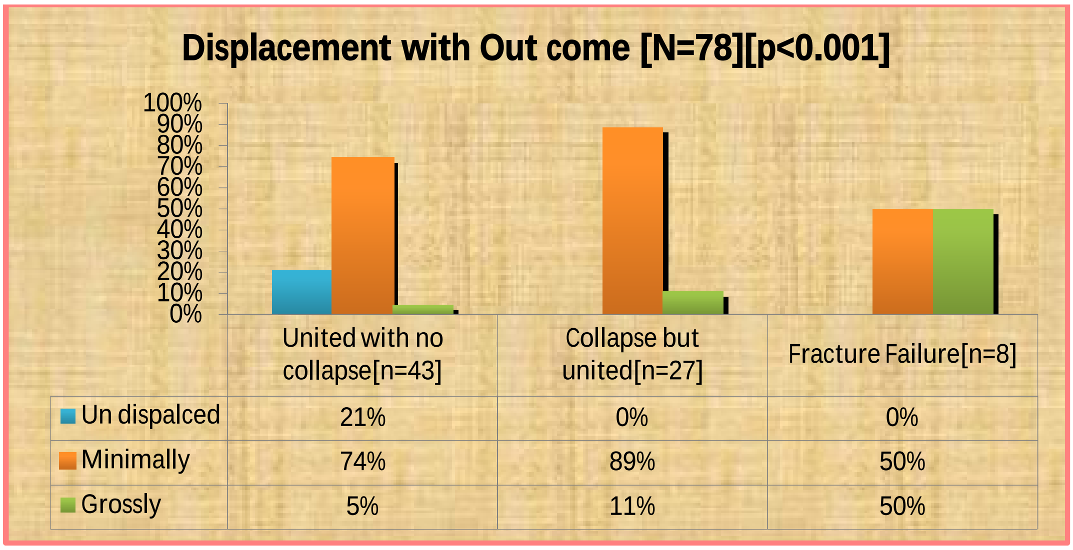
	Out come				
Medial butress	United with no collapse	Collapse but not united	Fracture Failure	Total	(%)
Intact	15	6	1	22	28%
Lost	28	21	7	56	72%
Total	43	27	8	78	



Out of 78 patients,22 had intact medial buttress and 56 had lost medial buttress. Out of 22 patients who had intact medial buttress 15 patients showed union with no collapse , for 6 patients there was union with collapse and 1 patient had fracture failure. In total of 58 patients who had lost medial buttress 28 showed union with no collapse, 21 showed union with collapse and 7 showed fracture failure.($P > 0.05$)

Displacement:

Displacement	Out come United with no collapse	Collapse but not united	Fracture Failure	Total	(%)
Undispalced	9	0	0	9	12%
Minimally	32	24	4	60	77%
Grossly	2	3	4	9	12%
Total	43	27	8	78	

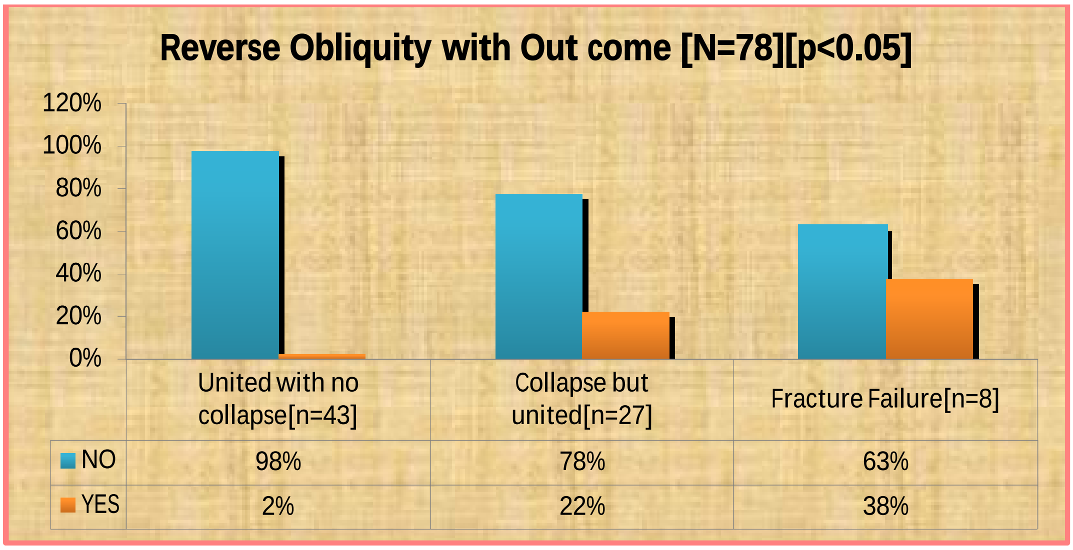


Out of 78 patients, there were 9 undisplaced fractures, 60 minimally displaced fractures and 9 grossly displaced fractures.All the undisplaced fractures united without any collapse.In 60 minimally displaced fractures 32 showed union without collapse, 24 showed union with collapse and 4 had fracture failure.In 9 grossly displaced fractures 2 showed union with out collapse,3 showed union with collapse and 4 fracture failures.

Reverse obliquity:

Reverse Obliquity with Out come

Reverse Obliquity	Out come: United with no collapse	Collapse but not united	Fracture Failure	Total	(%)
NO	42	21	5	68	87%
YES	1	6	3	10	13%
Total	43	27	8	78	

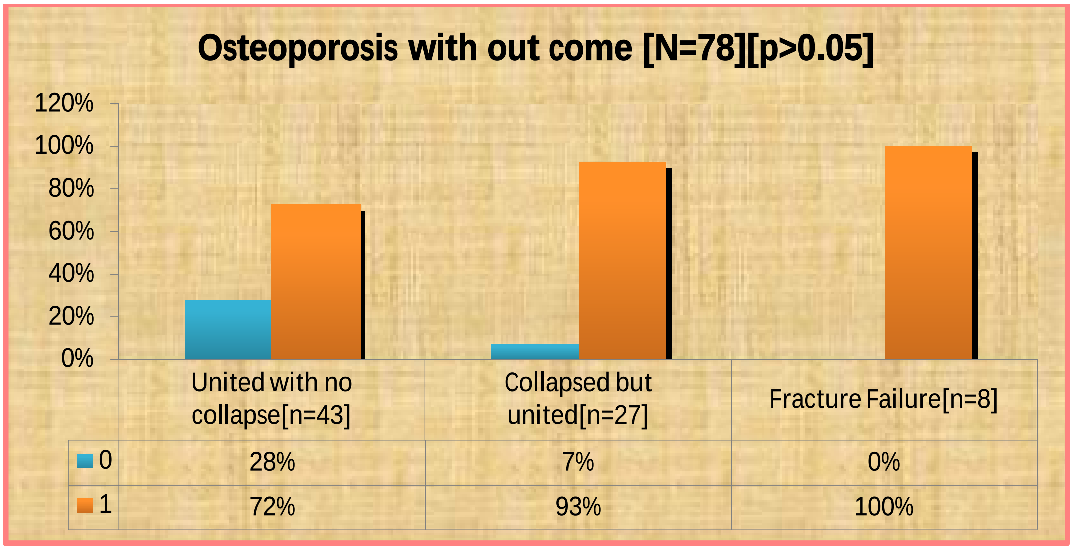


In total of 78 patients reverse oblique type of fracture pattern was seen in 10 patients.In 10 patients who had reverse oblique type of fracture pattern 1 showed union without collapse , 6 patients showed union with collapse , and 3 had fracture failure.In 68 patients without reverse obliquity 42 patients had union without collapse , 21 showed union with collapse , 4 had fracture failure failure. (P< 0.05)

Osteoporosis:

Osteoporosis with Out come

Osteoporosis	**Out come** United with no collapse	Collapse but not united	Fracture Failure	Total	(%)
NO	5	0	0	5	6%
YES	38	27	8	73	94%
Total	43	27	8	78	



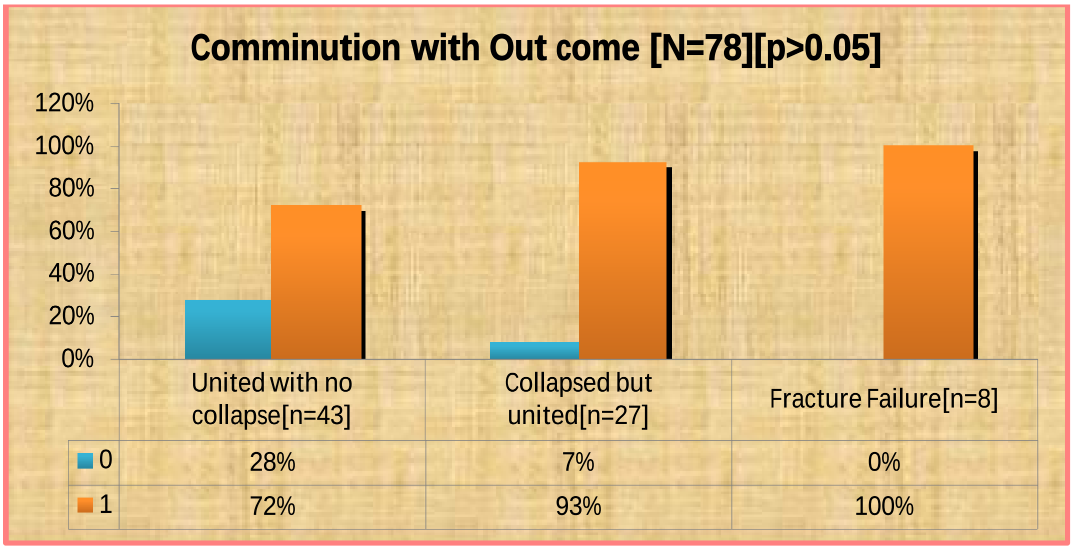
Out of 78 total patients osteoporosis was present in 73 patients (94%) and only 5 patients (6%) had no osteoporosis. Out of 73 patients who had osteoporosis 38 patients showed union without collapse, 27 patients showed union with collapse and 8 had fracture failures.In 5 patients who had no osteoporosis all fractures were united without collapse. (P> 0.05)

Comminution:

In a total of 78 patients, 64 patients had comminution at fracture site and 14 patients had no comminution at fracture site. In patients who had 2 part fracture 12 united with no collapse and in 2 patients fracture united with collapse. In 64 patients who had comminution at fracture site 31 cases united with no collapse,25 united with collapse and 8 patients had fracture failure. (P> 0.05)

Comminution with Out come

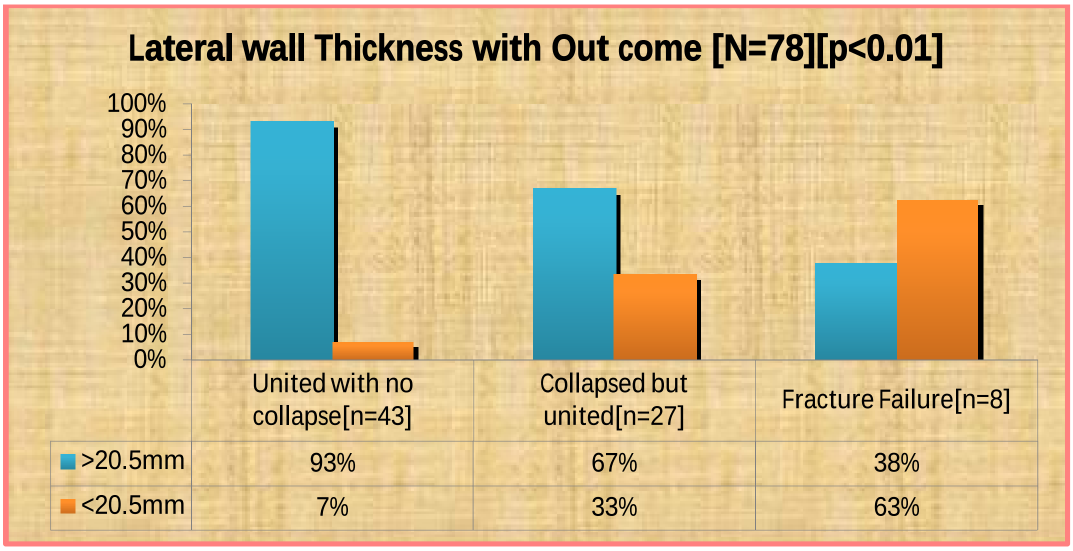
Comminution	**Out come**			Total	(%)
	United with no collapse	Collapse but not united	Fracture Failure		
NO	12	2	0	14	18%
YES	31	25	8	64	82%
Total	43	27	8	78	



Lateral wall thickness:

Lateral Wall Thickness with Out come

Lateral wall Thickness	**Out come** United with no collapse	Collapse but not united	Fracture Failure	Total	(%)
>20.5mm	40	18	3	61	78%
<20.5mm	3	9	5	17	22%
Total	43	27	8	78	



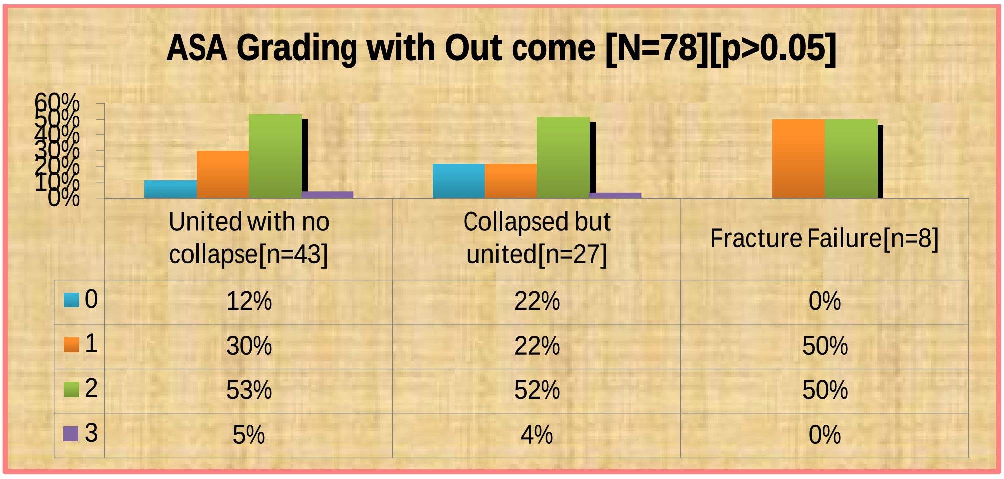
Out of 78 total patients, 61 patients had adequate lateral wall thickness and 17 patients lacked. Of 61 patients who had adequate lateral wall thickness 40 cases united with no collapse , 18 cases united with collapse and 3 fracture failures. In 17 patients with inadequate lateral wall thickness 3 cases united without collapse, 9 cases united with collapse and 5 patients had fracture failure.

(P< 0.01)

ASA grading:

ASA Grading with Out come

ASA	Out come: United with no collapse	Collapsed but United	Fracture Failure	Total	(%)
0	5	6	0	11	14%
1	13	6	4	23	29%
2	23	14	4	41	53%
3	2	1	0	3	4%
Total	43	27	8	78	

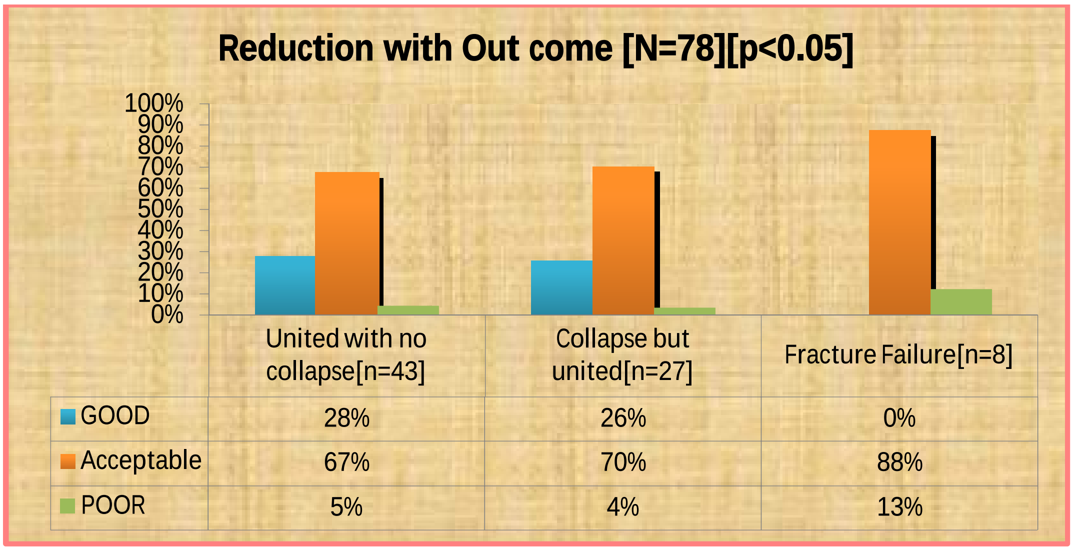


Out of total 78 patients , 11 patients came under ASA grade 0, 23 came under grade 1, 41 patients came under grade 2 , 3 came under grade 3.Out of 11 patients who came under ASA grade 0, 5 cases united with no collapse and 6 cases united with collapse. Out of 23 patients who came under ASA grade 1 , 13 cases showed union without collapse, 6 cases showed union with collapse and there were 4 fracture failures. Out of 41 cases which came under ASA grade 2 , 23 cases showed union without collapse , 14 showed union with collapse and there were 4 fracture failures.In 3 patients who came under ASA grade 3 , 2 cases united without any collapse and 1 united with collapse.

Reduction:

Reduction with Out come

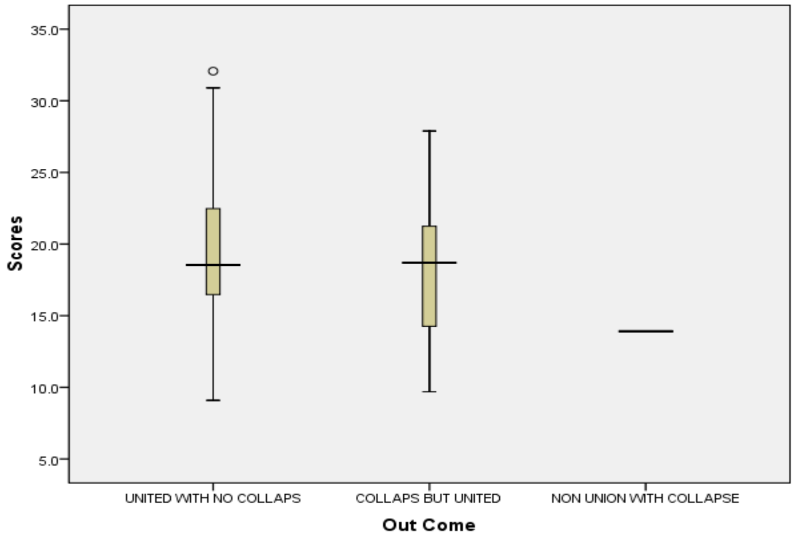
Reduction	Out come: United with no collapse	Collapse but not united	Fracture Failure	Total	(%)
GOOD	12	7	0	19	24%
Acceptable	29	19	7	55	71%
POOR	2	1	1	4	5%
Total	43	27	8	78	



Out of 78 patients , 19 patients had good reduction,55 patients had acceptable reduction and 4 patients had poor reduction. In 19 patients who had good reduction 12 cases had union without collapse and 7 patients had union with collapse. Out of 55 patients who had acceptable reduction 29 patients had union without collapse, 19 patients had union with collapse , and there were 7 fracture failures. Out of 4 patients who had postoperative poor reduction union without collapse was seen in 2 patients, union with collapse was seen in 1 patient and in 1 patient there was fracture failure.

Mean Tip Apex Distance

MeanTip Apex Distance of Study Groups							
Study Group	Mean	SD	95% CI for Mean		Minimum	Maximum	Sig
			Lower	Upper			
United with no collapse	20.0	6.0	17.1	22.9	9.1	32.1	
collapsed but united	18.2	4.5	15.7	20.8	9.7	27.9	
Fracture Failure	13.9	.	.	.	13.9	13.9	>0.05
Total	19.1	5.4	17.2	20.9	9.1	32.1	



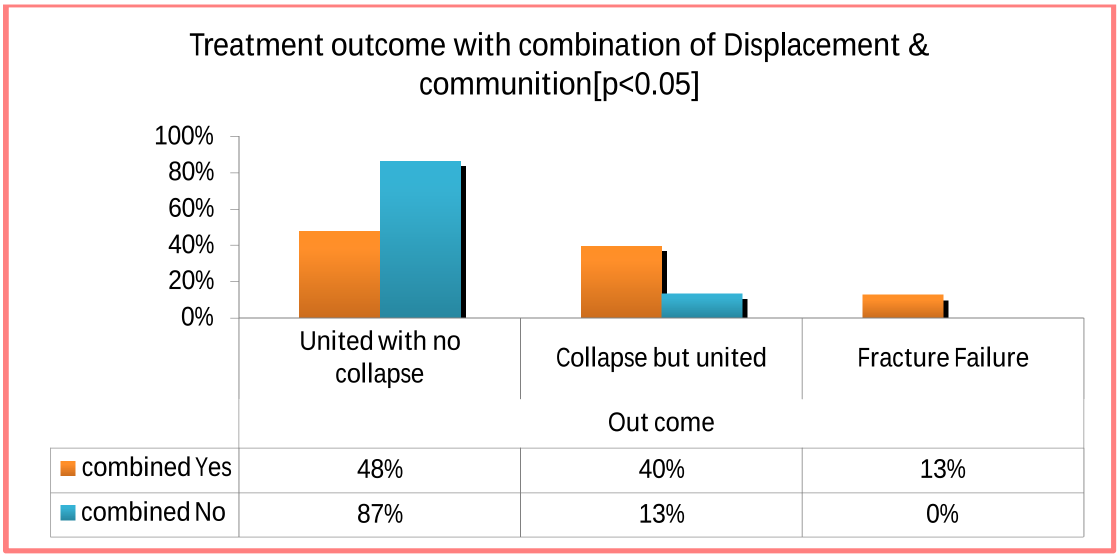
Out of 35 patients in whom tip apex distance was analysed the mean tip apex distance was 20.0 in patients who had union without collapse , 18.2 in patients who had union with collapse and 13.9 in patients with fracture failure. The P value was found to be > 0.05 which was not significant.

Displacement and Comminution:

Association of Out come with Combined variables [Dis &Comm]

Out come combinedCrosstabulation

			combined		
			Yes	No	Total
Out come	United with no collapse	n	30	13	43
		%	47.60%	86.70%	55.10%
	Collapsed but united	n	25	2	27
		%	39.70%	13.30%	34.60%
	Fracture Failure	n	8	0	8
		%	12.7%	0.0%	10.3%
Total		n	63	15	78
		%	100.00%	100.00%	100.00%

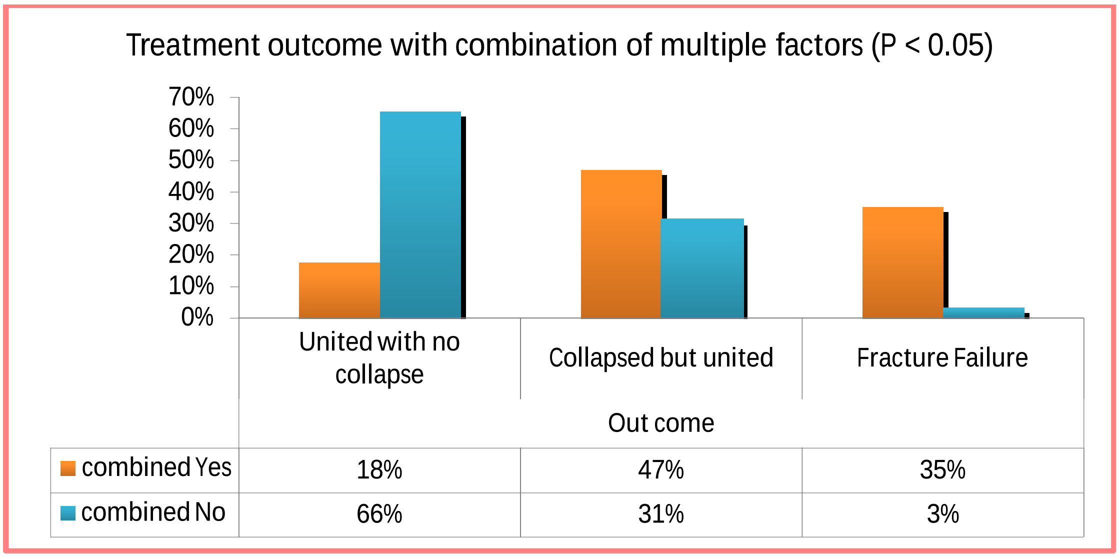


Out of 78 patients , 63 patients had combination of displacement and comminution. Of these 63 cases 30 cases had union without collapse, 25 had union with collapse , and there were 8 fracture failures.The P value was found to be significant (P< 0.05)

Loss of medial buttress, Displacement, Comminution& lateral wall thickness:

Association of Out come with Combined variables [LMB,Dis,Comm& LWT]
Out come * combined Crosstabulation

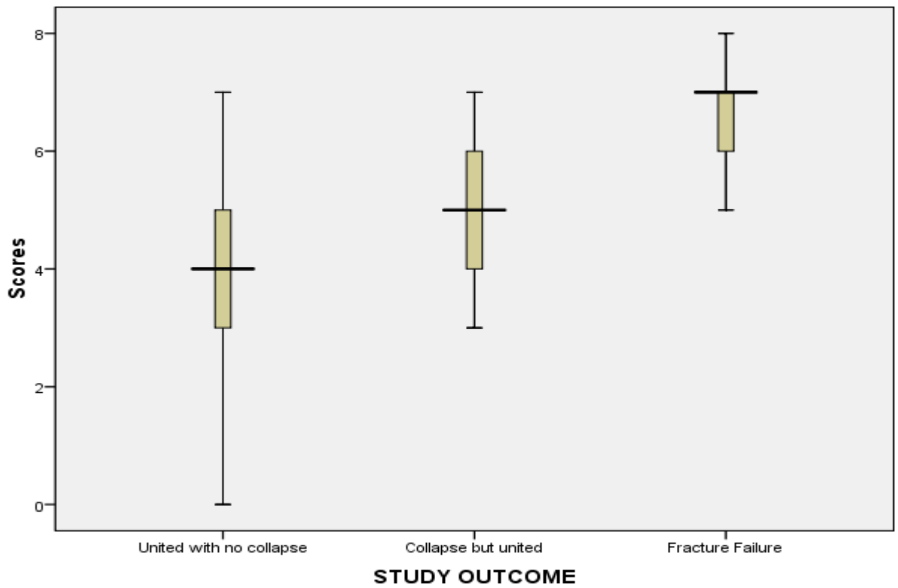
			combined		Total
			Yes	No	
Out come	United with no collapse	N	3	40	43
		%	17.65%	65.57%	55.10%
	Collapse but united	N	8	19	27
		%	47.06%	31.15%	34.60%
	Fracture Failure	N	6	2	8
		%	35.3%	3.3%	7.70%
Total		N	17	61	78
		%	100.00%	100.00%	100.00%



Out of 78 patients, 17 patients had combination of loss of medial buttress,comminution,displacement and lateral wall thickness of < 20.5 mm.Out of these 17 cases 3 had union without collapse,8 had union with collapse, and 6 had fracture failure.

Outcome assessment score:

OUT COME ASSESSMENT SCORES							
Study Group	Mean	SD	95% CI for Mean		Minimum	Maximum	Sig
			Lower	Upper			
United with no collapse	3.93	1.70	3.41	4.45	0	7	
Collapsed but united	5.19	1.33	4.66	5.71	3	7	
Fracture Failure	6.62	0.92	5.86	7.39	5	8	<0.001
Total	4.64	1.74	4.25	5.03	0	8	



In this study we devised a scoring system to assess the outcome in treatment of trochanteric fractures based on fracture pattern. Least score of 0 and maximum score of 8 was seen in study participants. A mean score of 3.93 was seen in patients who had union with no collapse, 5.19 in patients who union with collapse and 6.62 in patients who had fracture failure. Out of 24 patients who had a score of ≥ 6 , 25% of patients had union without collapse, 46% of patients had union with collapse and 29% of patients had fracture failure. The P value was found to be significant. (P < 0.001)

DISCUSSION

Treatment of intertrochanteric fractures is mainly surgical.Despite long term experience in many centres , there still are factors contributing to poor outcome in managing unstable intertrochanteric fractures.Controversies persist because there is lack of properpreoperative risk factors assessment that affect the outcome in these fractures treated by various modalities.

This study was carried out in our institute and a total of 78 patients were included.All the risk factors were assessed preoperatively and postoperatively and compared with radiological outcome.The follow up was upto 4 months with a minimum follow up of 2 months.

Trochanteric severity score:

In this study we have devised a new scoring system based on all fracture patterns comparing it with the outcome. The outcome was found to be significant with P value < 0.001. Till date there was no such scoring system designed for preoperative assessment of risk factors in the available literature comparing them with the outcome.

Loss of Medial buttress:

According to **MervynEvans**Intertrochantric fractures are considered as stable or unstable depending upon integrity of posteromedial cortex. Fractures with intact posteromedial cortex are considered as stable fractures while fractures with loss of posteromedial cortex are considered as unstable fractures.Postero medial cortex constitutes mainly the lesser trochanter.

Out of 78 patients, 22 had intact medial buttress and 56 had lost medial buttress.This also correlated with the finding of **Jacobs and coworker (1980)**[49] that incidence of comminuted unstable intertrochanteric fractures is increasing.In this study we have found that incidence of unstable fractures was 72%.In addition to the incidence of unstable intertrochanteric fractures we also compared the loss of medial buttress with the the radiological outcome.But in that comparison we have found that P> 0.05.

Displacement:

In our study fracture displacement was divided into undisplaced,minimally displaced and grossly displaced. We have observed that all undisplaced fractures showed perfect anatomical union, minimally displaced fractures showed union with collapse and grossly displaced fractures showed high incidence of fracture failures.(50%) The P value was found to be significant. (P< 0.01)Our results in this study were compared with **Litchblau**observation on unstable intertrochanteric fractures stating that displacement as one of the risk factors for unstable intertrochanteric fracture.[37]

Reverse obliquity:

In our study out of total 78 patients , 10 patients had reverse oblique type of fracture pattern.In patients having reverse oblique type of fracture pattern 38% had fracture failure. With the above results DHS is found to be not a suitable implant in treatment of reverse oblique type of fracture pattern**. Sadowski CAL et al.** in their study on treatment of intertrochantric fractures with reverse oblique fracture pattern.Implant failure or nonunion was noted in seven of the nineteen patients (38%) who had been treated with the screw-plate. Only one of the twenty fractures that had been treated with an intramedullary nail did not heal.This supported the use of intramedullary nail rather than the use of blade plate for these fracture pattern.[50]Hence sliding hip screw is not an ideal implant in treatment of these fractures.

Osteoporosis:

Out of 78 patients , 73 had osteoporosis.(94%)The degree of osteoporosis is estimated by singhs index. In patients who had osteoporosis 8 patients had fracture failure, 27 patients showed union with collapse and 38 had union without any collapse.The P value was found to be more than 0.05.(P>0.05).Till date there was not much of literature available comparing the outcome with osteoporosis.In a study done by **Tony Setiobudi et al.** they have observed that singh index was 4 +/- 1.24 in stable intertrochanteric fractures and 4 +/- 1.20 in unstable intertrochanteric fractures.

Comminution:

In the present study, out of 78 patients 64 cases had comminution at fracture site. In cases having comminution at fracture site 31 cases had union without any collapse,25 cases showed union with collapse , 8 cases showed fracture failure.The P value is more than 0.05. ($P > 0.05$) Our results were compared with **Litchblau** report stating that comminutionat fracture site is one of the risk factor for intertrochanteric fractures but not significantly affecting the outcome.[37]

Lateral Femoral wall thickness:

Of 78 patients , 17 patients had inadequate lateral wall thickness (< 20.5 mm). Out of these cases 3 had union without any collapse, 9 fractures showed union with collapse and 5 had fracture failure.(29%) The P value was found to be < 0.01. ($P < 0.01$)

The results of our study are compared with **Henrik palm et al.** work. In their study they observed that only 3% of 168 patients with an intact lateral femoral wall underwent reoperation within 6 months, whereas 22% of 46 patients with a fractured lateral wall were operated once again. They concluded that patients with preoperative or intraoperative fracture of the lateral wall are not treated adequately with sliding compression screw device.[51]

Our results were also compared with **C-E hsu et al.**study on lateral wall thickness.In their study they observed that 19 of 39 patients with lateral wall fracture(48.7%) had failures. They concluded that fracture classification and lateral wall thickness significantly contributed to postoperative lateral wall fracture. They also concluded that intertrochanteric fractures with lateral wall thickness < 20.5 mm should not be treated with sliding hip screw alone.[52]

General physical status:

General physical status of the patients was assessed using ASA grading.Out of total patients 11 came under grade 0, 23 came under ASA grade 1, 41 came under ASA grade 2 and 3 of cases came under ASA grade 3.Till date there was not much available literature comparing the physical status of the patient with the fracture treatment outcome. The P value was found to be not significant in our study. (P > 0.05) **Tony Setiobudi et al.** in their study observed that 47.5% of 61 patients with stable intertrochanteric fractures fell under ASA grade 2 and 41.0% of 78 unstable intertrochanteric fell under ASA grade 1.

Reduction:

Out of total 78 patients , 19cases had good reduction, 55 had acceptable reduction and 4 cases had poor reduction. In patients who had good reduction there wasperfect anatomical union and in cases with acceptable and poor reduction there was union with collapse and fracture failures.**In 2012 Emrahsahin et al.** compared the quality of fracture reduction between intramedullary and extramedullary implants and they have observed not much of statistical difference. (P = 0.83) In our study we have compared the fracture reduction with radiological outcome and we have observed that fracture failures are more commonly seen in fractures with poor reduction.The P value was found to be significant. ($P<0.05$)

Tip Apex Distance:

In the study of **Michael R. Baumgaertner** et al. on tip apex distance they have observed that the mean TAD was 20 mm in the study group and 25 mm in control group. They also observed that there were no cut-out failures in 118 fractures of study group at a mean follow-up of 8 months compared with 16 of 198 in the control group.[54] In our study we have analyzedtip apex distance (TAD) for only 35 patients. The mean tip apex distance was 20.0mm in patients who had union without collapse , 18.2 in patients who had union with collapse and 13.9 in patients with fracture failure.The P value was found to be >0.05. Our results are not comparable with the above study.

Displacement and comminution:

In this study we compared the combination of displacement and comminution with the outcome. We observed that 100% of patients with fracture failure had combination of these two factors. From this we concluded that combination of these two variables had a significant affect on the outcome.No studies were done comparing these two variables with the outcome.

Combination with Loss of medial buttress, Displacement, Comminution and lateral wall thickness:

Out of 78 patients,17 patients had combination of all these factors. In 17 patients 6 had fracture failure (35.3%), 8 had union with collapse and 3 had anatomical union. From the above results we concluded that combination of multiple factors had fracture failures and non anatomical union.

CONCLUSION

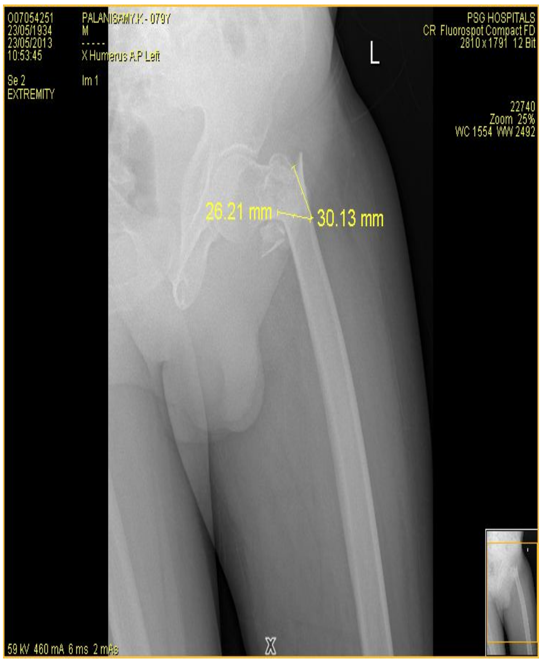
- Trochanteric severity score is a useful tool to assess the outcome of management of intertrochanteric fractures.
- Sliding hip screw is still a good implant for majority of intertrochanteric fractures.
- When treated by sliding hip screw, Trochanteric fractures with inadequate lateral wall thickness has showed a very high failure rate.(63%)
- Reverse oblique type of trochanter fractures had a high failure rates.(50%)
- Displaced comminuted fractures had a failure rate of 13%.
- Above factors when it occurred in combination the failure rates significantly increased. Sliding hip screw may not be an ideal implant for thesekind of fractures.

LIMITATIONS

- Small sample size
- Technical details in fracture fixation were not adequately analysed.
- Other forms of fixation of trochanter fractures were not compared in the study.

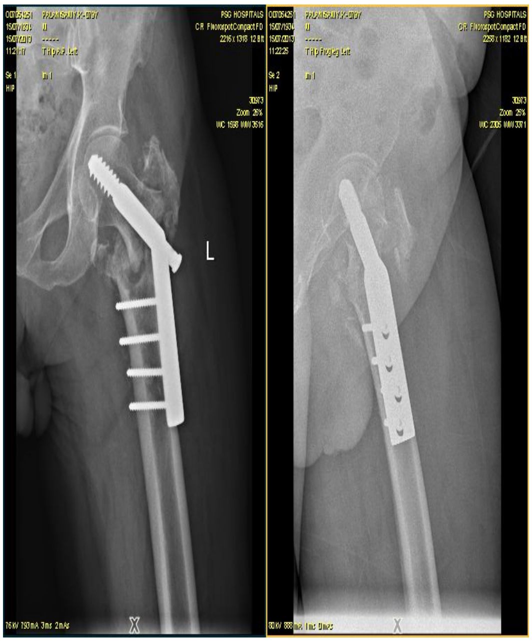
Failure X -Rays

Case No. 1



Pre- OP

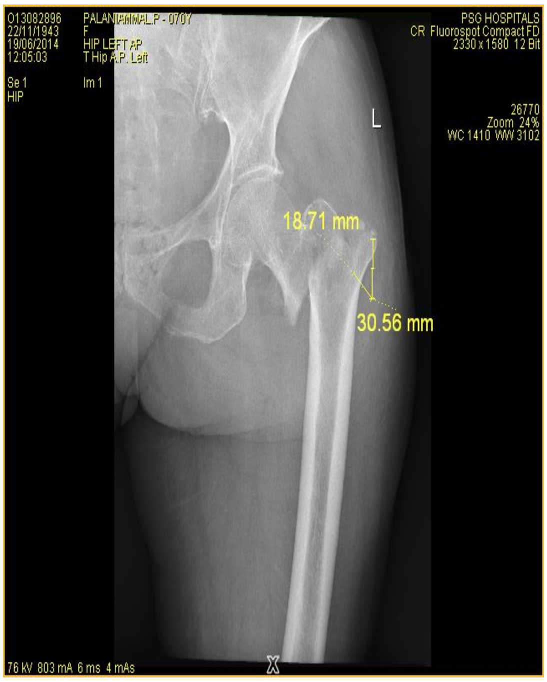
Imeediate Post - Op



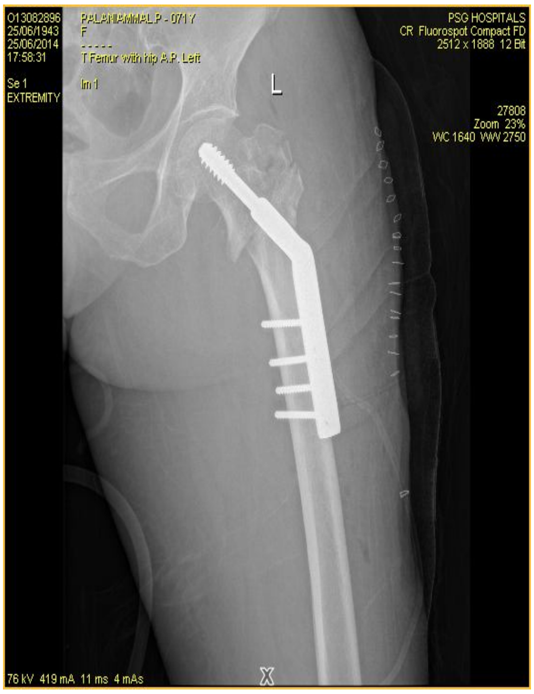
1 Month Follow up

> 2 Months

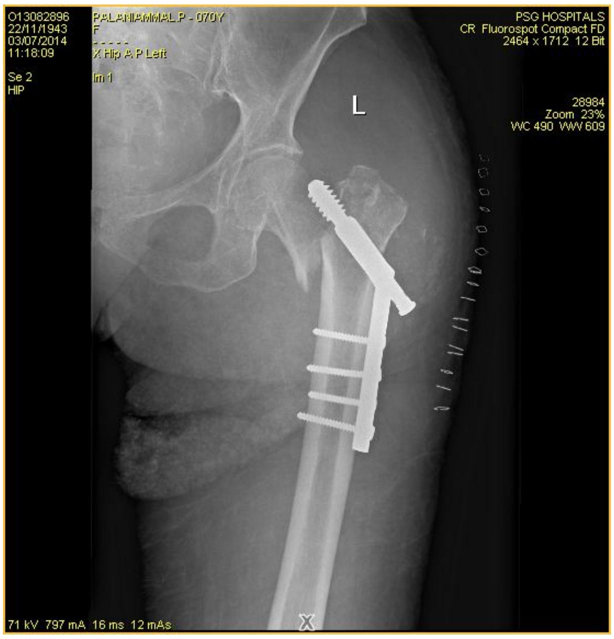
Case No. 2



Pre- OP



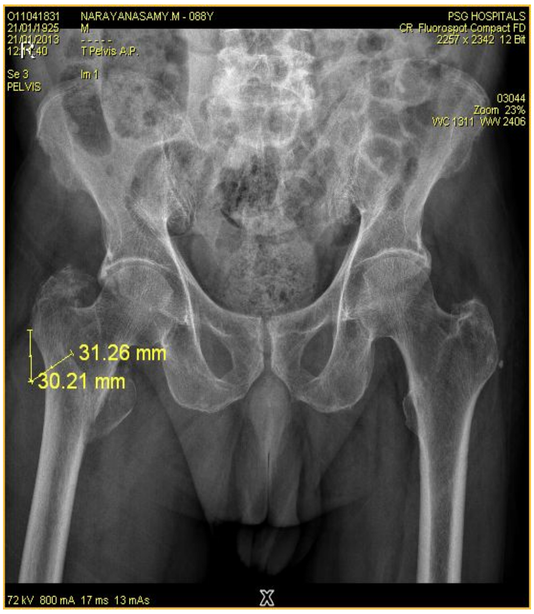
Imeediate Post - Op



15 Day Follow up

United Without Collapse

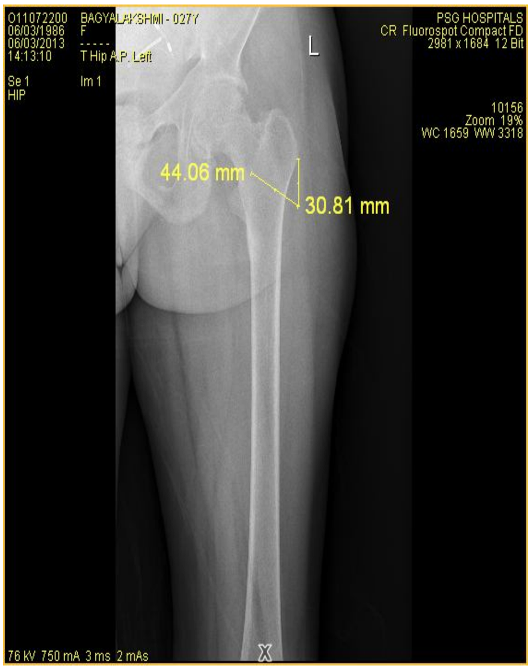
Case No. 1

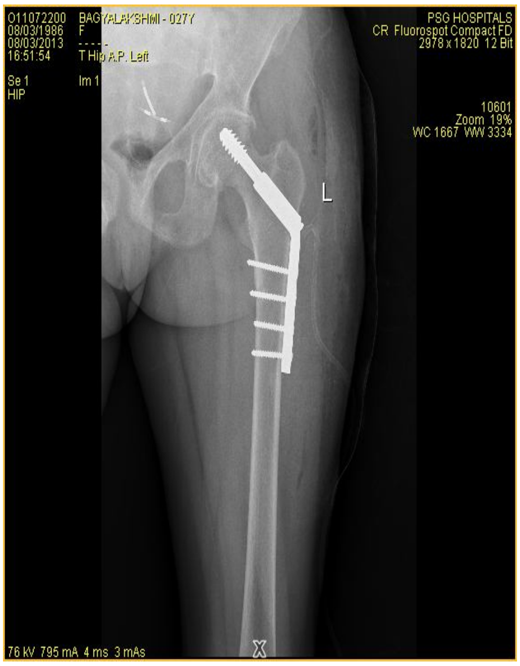


Pre- OP **Imeediate Post - Op**

> 2 Months Follow up

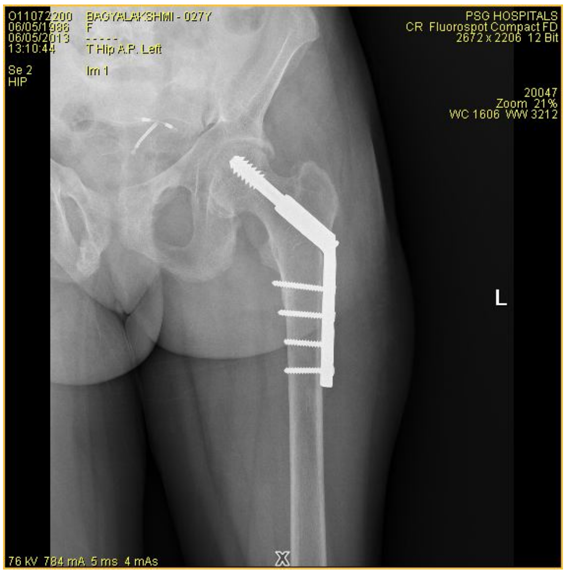
Case No. 2





Pre- OP

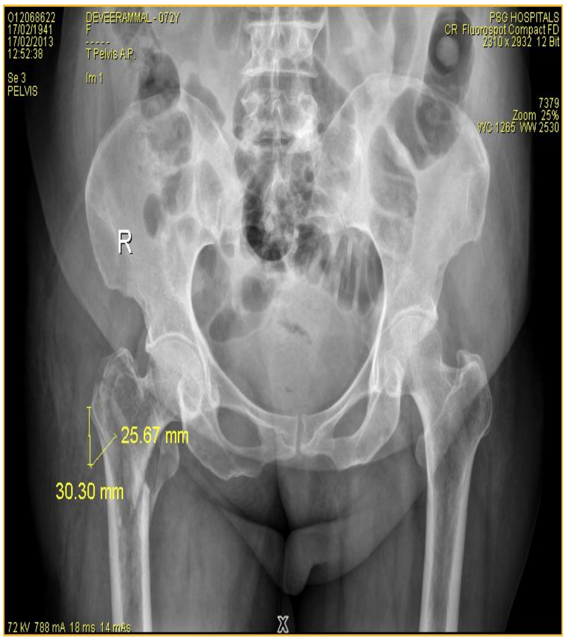
Imeediate Post - Op



> 2 Months Follow up

Collapsed but United

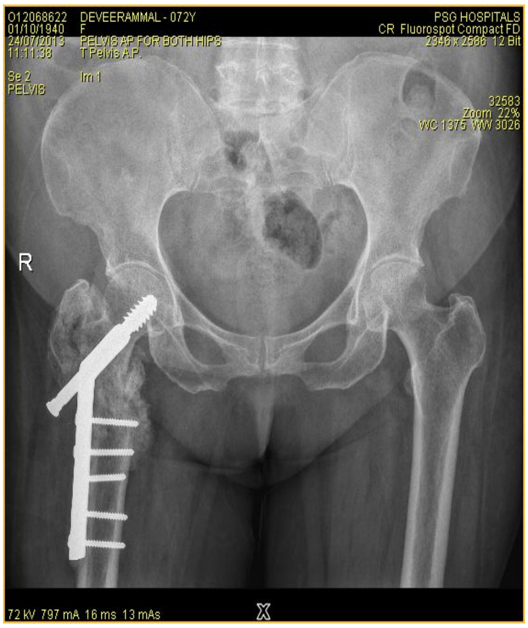
Case No. 1



Pre- OP

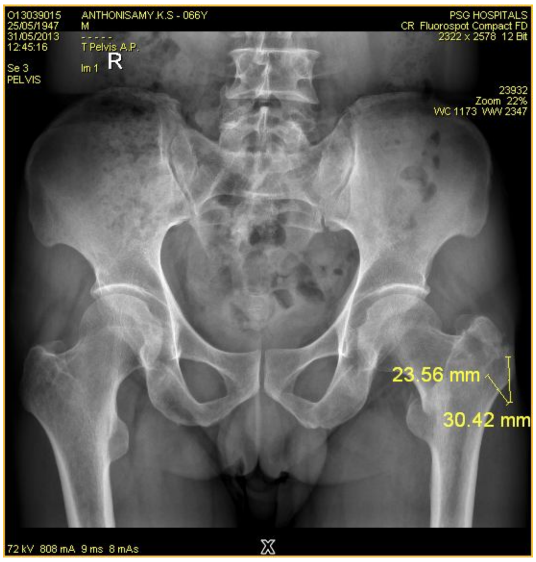
Imeediate Post - Op

1 Month Follow up

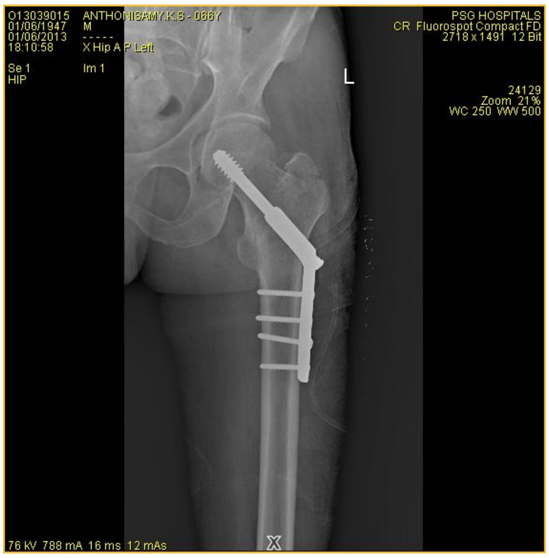


> 2 Months Follow up

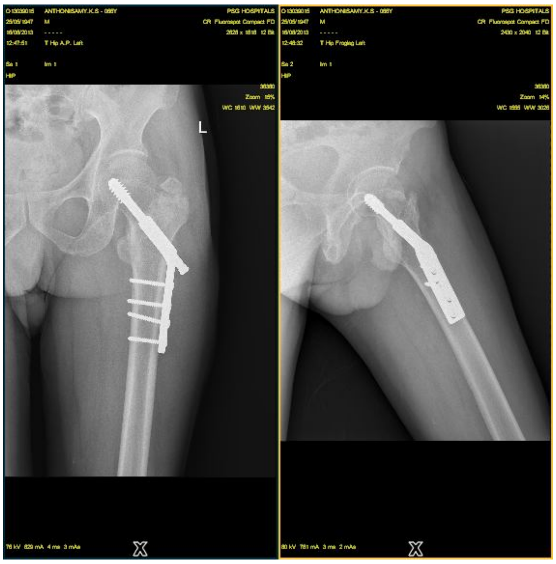
Case No. 2



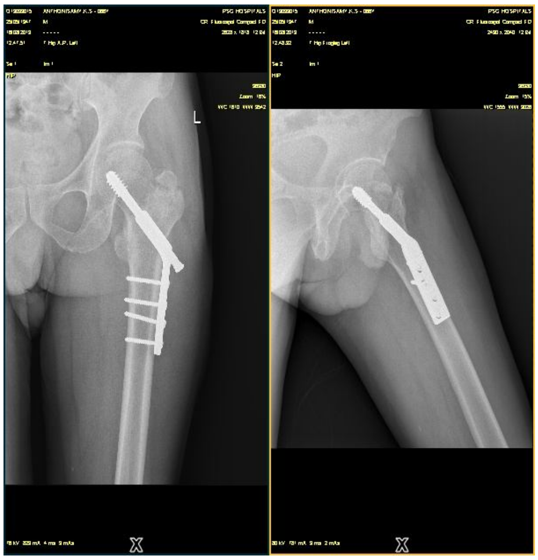
Pre- OP



Imeediate Post - Op



1 Month Follow up



> 2 Months Follow up

BIBLIOGRAPHY

1. Babhulkar S. Management of trochanteric Fractures. Indian Journal of Orthopaedics. 2006;40(4):210.
2. Rockwood C, Green D, Bucholz R. Rockwood and Green's fractures in adults. Philadelphia: Lippincott Williams & Wilkins; 2006.
3. Singh A, Thong G, Laloo N, Singh A, Singh S. Management of trochanteric fractures. Indian Journal of Orthopaedics. 2006;40(2):100.
4. Cooper A. Fractures and Dislocations of Joints. 10^{th} ed. London,1839
5. Bick E. Source Book of Orthopaedics. Newyork: Hafner,1968.
6. Heyse- moore et al; Treatment of intertrochanteric fractures of femur JBJS 1983; 65-B; 262-267.
7. Schumpelick.W; Jantzen OM; A new principle in orthopaedic treatment of trochanteric fractures of femur JBJS july 1995; 37-4.
8. Whitmann R. A new method of treatment for fractures of the neck of the femur,together with remarks on coxavara.AnnSurg 1902;36:746.
9. Massie WK: Extracapsular fractures of the hip treated by impaction using a sliding Nail-plate fixation. Clin Orthop1962; 180-202.
10. Jewet et al; One piece angle nail for trochanteric fractures JBJ S1941; 23, 803.
11. Capener N. The treatment of pertrochanteric fractures. J Bone Joint Surg Br August 1, 1957 1957;39-B(3):436-437.
12. Taylor MN,JanzenJ.Internal fixation for intertrochanteric fractures I. J Bone Joint Surg Am 1944;26(4):707-712.

13. Boyd HGLL. Classification and treatment of trochanteric fractures. Arch Surg 1949; 58:853-863.
14. Boyd H,Anderson LD. Management of unstable trochanteric fractures. Surggynecol Obstetrics 1961;55:853-863.
15. .Bendo JA, Weiner LS, Strauss E, et al. Collapse of intertrochanteric hip fractures fixed with sliding screws. Orthop Rev 1994;Suppl:30-37.
16. Dimon JHJC. Unstable intertrochanteric fractures the hip. J Bone Joint Surg Am 1967;49(3):440-450.
17. Harrington KJ. The management of comminuted unstable intertrochanteric fracture. J Bone Joint Surg Am 1973;55(7):1367-1376.
18. Sarmiento A. intertrochanteric fractures of the femur:150-degree – angle nail-plate fixation and early rehabilitation: a preliminary report of 100 cases. J Bone joint Surg Br 1995;77(1):90-92.
19. Desjardins ARA, Paiement G, newman N, et al. Unstable intertrochanteric fracture of the femur. A prospective randomized study comparing anatomical reduction and medial displacement osteotomy. J Bone Joint Surg Br 1993;75(3):445-447.
20. Gargan MGR, Simpson AH. How effective are osteotomies for unstable intertrochanteric fractures? J Bone Joint Surg Br Sep 1994; 76(5): 789-792.
21. Parker MJ, Handoll HH, Bhargara A. Conservative versus operative treatment for hip fractures. Cochrane Database Syst Rev

2000(4):CD000337.

22. The use of Ender's pin in extra capsular fractures of hip JBJS 1981; 63; 14-28
23. Kosygan KP, Mohan R Neuman RJ; The Gotfried percutaneous compression plate compared with conventional classical hip screw fixation of intertrochanteric fractures of hip JBJS Jan 2002; 84(1); 19-22
24. YeetrielGotfried; Percutaneous compression plating of pertrochanteric hip fractures MO; Dept Of Orthopedic surgery; Bnai Zion Medical center, Haifa Israel.
25. Medoff RM. A new device for the fixation of unstable pertrochanteric fractures of the hip. J Bone Joint Surg Am 1991;73(8):1192-1199.
26. Lunsjo KC, Stigsson L, Hauggard A. One way compression along the femoral shaft with the medoff sliding plate. The first European experience of 104 intertrochanteric fractures with a 1-year follow up.ActaOrthopScand 1995;66(4):343-346.
27. Watson JM, Cramer KE, karges DE. Comparison of the compression hip screw with the medoff sliding plate for intertrochanteric fractures.Clinorthop 1998(348):79-86.
28. Janzing H M, Houben B T, Brandt S E, et al; the percutaneous compressionPlate verses the dhs in the treatment of pertrochanteric hip fracture. MinimalInvasive treatment reduces operative time and post operative pain ; J trauma2002 , 52:293.

29. Hardy D C, Drossos K; Sloted intramedullary hip screw nail reduces proximal mechanical unloading ,Clinorthoprelat res,2003, 406:176.
30. N K karn,G K sing,Bshrestha, M P singh; comparission between external Fixator and sliding hip screw in the management of trochanteric fracture of Femur in Nepal ; J B J S 2006 (british) 88-b, 1347-1350.
31. Yechielgotfried ; integrity of the lateral femoral wall in intertrochanteric Hip fracture an important predictor of a reoperation; J B J S 2007, 89; 2552-2553.
32. Boyd and griffin: Classification and treatment of trochanteric fractures; Arch surg; 1949;58; 853-866.
33. Evans E ; The treatment of trochanteric fractures of femur J b j s 1949; 191;53-63.
34. Kyle. RF; Right TM; Biomechanical analysis of the sliding characteristics of compression screws; JBJS 1980; 62-A; 1308.
35. M.E.Muller, S.Nazarian, P.Koch, J.Schatzker The comprehensive classification of fractures of long bones Springer, Berlin. 1990.
36. Kulkarni G, Limaye R, Kulkarni M, Kulkarni S. Intertrochanteric fractures. Indian Journal of Orthopaedics. 2006;40(1):16.
37. Lichtblau S. The Unstable Intertrochanteric Hip Fracture. Orthopedics. 2008;31(8):792-797.
38. Cummings SR, Nevitt MC. A hypothesis: the causes of hip fractures. J Gerontol 1989;44(4):M107-111.

39. Hopkinson-Woolley JA, Parker MJ.Fractures of the hip: does the type of fall really affect the site of fracture? Injury 1998;29(8):585-587.
40. Lippmann RK. The use of ausculatory percussion for the examination of fractures. J Bone Joint Surg 1932;14:118.
41. KovalKJ, Friend KD, Aharonoff GB, et al. Weight bearing after hip fracture: a prospective series of 596 geriatric hip fracture patients. J Orthop Trauma 1996; 10(8):526-530.
42. Rizzo PF, Gould ES, Lyden JP, Asnis SE. Diagnosis of occult fractures about the hip.magnetic resonance imaging compared with bone-scanning. J Bone Joint Surg Am 1993;75(3):395-401.
43. Verbeeten KM, Hermann KL, Hasselqvist M, et al. The advantages of MRI in the detection of occult hip fractures.EurRadiol 2005;15(1):165-169.
44. Setiobudi T, Ng Y, Lim C, Liang S, Lee K, De S. Clinical outcome following treatment of stable and unstable intertrochanteric fractures with dynamic hip screw. Ann acad Med. 2011;(40):482-487.
45. M.Bombart, J.O Ramadier trochanteric fractures Rev Chir Orthop,52 (1966), 353-374.
46. Tronzo RG. Symposium on fractures of the hip.Special consideration in management.OrthopClin North AM. 1974;5(3):571-583.
47. Marsh C. Use of-Ender's nails in unstable trochanteric femoral fractures.Journal of the Royal Society of Medicine. 1983;74:550-554.
48. Russell T. Introduction. TechnOrthop 2008;23:2.

49. Jacobs RR, McClain O, Armstrong HJ: Internal fixation of intertrochanteric hip fractures, ClinOrthop Related Res 146:62.

50. Sadowski CAL, Saudan M, Riand N, Stern R, Hoffmeyer P. Treatment of reverse oblique and transverse intertrochanteric fractures with use of an intramedullary nail or a 95° Screw-Plate: A Prospective, Randomized Study. J Bone Joint SurgAmrt 2002; 84:; 372-81.

51. Palm H. Integrity of the Lateral Femoral Wall in Intertrochanteric Hip Fractures: An Important Predictor of a Reoperation. The Journal of Bone and Joint Surgery (American). 2007;89(3):470.

52. Hsu C, Shih C, Wang C, Huang K. Lateral femoral wall thickness: A reliable predictor of post-operative lateral wall fracture in intertrochanteric fractures. The Bone & Joint Journal. 2013;95-B(8):1134-1138.

53. Şahin E, İmerci A, Kınık H, Karapınar L, Canbek U, Savran A. Comparison of proximal femoral nail antirotation (PFNA) with AO dynamic condylar screws (DCS) for the treatment for unstable peritrochanteric femoral fractures. Eur J OrthopSurgTraumatol. 2013;24(3):347-352.

54. Baumgaertner M, Solberg B. Awareness of tip-apex distance reduces failure of fixation of trochanteric fractures of the hip. The Journal of Bone and Joint Surgery. 1997;79(6):969-971.

MASTER CHART

OP Number	Medial butress	Displacement	Reverse Obliquity	Osteoporosis	Comminution	Lateral wall thickness	ASA Grading	Reduction	United with no collapse	Collapsed but united	Fracture Failure
O14008676	1	1	1	1	1	1	2	1		yes	
O07054251	1	1	0	1	1	0	2	2			yes
O11007557	1	1	0	1	1	0	2	0	yes		
O14028070	0	0	0	1	1	0	2	0	yes		
O11007583	1	1	0	0	1	0	3	1	yes		
O13003055	1	1	0	1	1	0	2	1	yes		
O11040831	1	1	0	1	1	0	3	1	yes		
O13005031	1	1	0	1	1	0	2	1		yes	
O13006024	0	0	0	1	0	0	0	0	yes		
O10033404	1	1	0	1	1	0	2	1	yes		
O12068622	1	1	0	1	1	0	2	1		yes	
O11072200	0	0	0	1	0	0	1	0	yes		
O02051858	0	1	0	1	0	0	2	1	yes		
O13018694	0	0	0	1	0	0	1	1	yes		
O11035736	1	1	0	1	1	0	2	1	yes		
O13027590	1	1	0	1	1	1	2	2		yes	
O13030784	1	1	0	1	1	0	2	1	yes		
O10018413	0	1	0	1	0	0	1	0	yes		
O13035877	1	1	0	1	1	0	2	1	yes		
O13017885	1	1	1	1	1	1	2	1		yes	
O13039015	0	1	0	1	1	1	2	1		yes	
O97049521	1	1	0	1	1	0	2	1	yes		
O11070163	0	0	0	1	0	0	1	0	yes		
O13050006	1	1	1	1	1	1	2	1			yes

O13049719	1	1	0	1	1	0	1	1		yes	
O13053176	1	1	0	1	1	1	2	1		yes	
O13045459	1	1	0	1	1	0	1	1	yes		
O13064106	1	2	0	1	1	1	1	1			yes
O08057056	1	1	0	1	0	0	1	1	yes		
O13051087	0	1	0	1	0	0	1	0		yes	
O13069728	1	1	0	1	1	0	2	1		yes	
O11023853	1	1	1	1	1	1	2	1			yes
O06002277	0	1	0	1	1	0	1	1		yes	
O13086197	1	1	0	1	1	1	2	1	yes		
O13029902	0	1	0	1	0	0	1	0	yes		
O04027581	1	1	0	1	1	0	2	1	yes		
O13091773	1	1	0	1	1	0	2	1	yes		
O12019090	1	1	0	1	1	0	2	1	yes		
O11049699	1	1	0	1	1	0	2	1			yes
O12011522	0	1	0	1	1	0	1	1		yes	
O08081311	1	1	0	1	1	0	0	0		yes	
O12042625	1	1	0	1	1	0	2	1	yes		
O12047185	1	1	0	1	1	0	2	1	yes		
O12052814	1	1	0	1	1	0	2	0	yes		
O12061034	0	1	0	1	1	0	2	1	yes		
O12066705	0	0	0	1	0	0	0	1	yes		
O12070274	1	1	0	1	1	0	1	1	yes		
O12085458	1	1	0	1	1	1	2	1	yes		
O12001700	1	2	0	1	1	0	1	1			yes
O12004713	1	1	0	1	1	0	2	0		yes	

O14032726	1	2	0	1	1	0	1	1	yes		
O14033740	1	1	0	0	1	0	0	1	yes		
O14034160	1	2	0	1	1	0	1	1		yes	
O97025359	0	0	0	1	0	0	2	1	yes		
O06022697	1	1	0	1	1	0	2	2	yes		
O13082896	0	2	1	1	1	1	1	1			yes
O14050503	1	1	0	1	1	0	0	0		yes	
O14041168	1	2	0	1	1	0	2	1		yes	
O14055953	1	2	0	1	1	0	1	1	yes		
O10029661	1	2	0	1	1	1	1	2			yes
O14006633	1	2	1	1	1	0	2	1		yes	
O12005586	0	1	1	1	0	0	0	0		yes	
O14064386	1	1	0	1	1	1	0	1		yes	
O14067148	1	1	0	1	1	1	2	1		yes	
O12027153	1	1	0	1	1	0	3	1		yes	
O11000917	1	1	0	1	1	0	2	1	yes		
O14080113	0	0	0	0	0	0	1	0	yes		
O05002153	0	0	0	0	0	0	1	1	yes		
O14051744	0	1	0	1	1	0	2	0	yes		
O15001301	1	1	0	1	1	0	2	0		yes	
O14025507	1	1	1	1	1	1	0	1		yes	
O15004948	1	1	1	1	1	1	0	1	yes		
O15011059	1	1	1	1	1	1	1	1		yes	
o15012709	1	1	0	0	1	0	0	1	yes		
O15014890	0	1	0	1	1	0	2	0		yes	
O15016528	0	1	0	1	1	0	2	0	yes		
O15018016	1	1	0	1	1	0	0	1		yes	
O13074276	1	1	0	1	1	0	1	0	yes		

OP Number	TAD	United With No Collapse	Collapsed But United	Fracture Failure
O07054251	13.91			yes
O11040831	32.07	yes		
O13005031	16.96		yes	
o02051858	30.12	yes		
O13018694	22.23	yes		
O13027590	19		yes	
O10018413	18.43	yes		
O13035877	14.19		yes	
O13017885	27.89		yes	
O13039015	21.65		yes	
O11070163	22.72	yes		
O13086197	20.87	yes		
O04027581	20.56	yes		
O08081311	17.9		yes	
O12052814	24.42	yes		
O12061034	13.58	yes		
O14032726	16.71	yes		
O97025359	19	yes		
O14050503	14.17		yes	
O14006633	21.02		yes	
O14064386	20.92		yes	
O12027153	14.34		yes	

OP Number	TAD	United With No Collapse	Collapsed But United	Fracture Failure
O11000917	16.24	yes		
O14080113	9.09	yes		
O05002153	15.45	yes		
O14051744	18.54	yes		
O15001301	21.47		yes	
O14025507	18.7		yes	
O15004948	30.9	yes		
O15011059	13.71		yes	
O15012709	16.74	yes		
O15014890	9.69		yes	
O15016528	15.42	yes		
O15018016	21.97		yes	
O13074276	16.96	yes		